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THE ACCELOGRAPH.

ON THE USE OF AN APPARATUS CALLED THE ACCELOGRAPH FOR MEASURING THE PRESSURES DEVELOPED BY GUNPOWDER GASES, AND FOR STUDYING THE LAWS OF THE RECOIL MOTION OF FIREARMS.

WHEN a projectile within a cannon is thrown out by the explosion of a charge of powder it is submitted to a suddenly developed pressure, the effects of which may be rendered very variable as regards the same gun and the same charge of powder, when the physical character of the latter (such as its density, and the form and size of its grains) is modified, or when the conditions of the loading, and particularly the initial space allowed the charge, are caused to vary.

These variations in the mode of action of gunpowder have for some years been closely studied with a view to obtaining an estimate of the pressure exercised by its gases on the projectile, and also for ascertaining the relative rapidity of the development of such pressure. And so, too, has been studied the law of the development of pressure produced by the combustion of powder inclosed, in various quantities, in an inclosed space.

The different apparatus that have been employed for measuring the sudden and energetic pressures developed by gunpowder gases, either in the firing of guns or during combustion in closed vessels, may be divided into two classes, according to the principle on which their mode of operation is based The pressures, in fact, are measured by the effort or power that they exercise on a given surface, and there exist only two ways of estimating them. In one of these, a known antagonistic force is opposed to the effect to be estimated, and by the aid of which an endeavor is made to bring it into equilibrium. This is the *static* method, on which is founded the use of the balance. In the other, the effects produced by the force that it is desired to estimate on the masses to which it is applied are studied, and the value of the law of the motion that it imparts to them is deduced therefrom. This is the *dynamic* method, use of which is made in astronomy when, from an observation of the motions of the stars, the value of the attractions to which they are submitted is deduced.

In applying either of these methods, it is customary to drill, in certain points of the chamber of the gun, a hole perpendicular to the inner surface, and in which is fitted accurately a piston-rod of known section; and the problem then hinges on an estimate of the effort exercised on the rod. We shall see, however, that in using the dynamic method we may, at least for the firing of guns, dispense with certain apparatus for perforating the sides of the piece.

To the category of static methods belongs the process employed by Count Rumford in his celebrated experiments between 1792 and 1797. To this class belong likewise the instruments which depend for their use on the disfigurement of objects, such, for instance, as the Rodman powder gauge, which is used in America, Italy, Russia, and also in Germany with some slight modification. This apparatus estimates the effort exercised on the piston by the length of a slit made in a fixed disk of copper by means of a steel knife blade. The apparatus called the crusher, which is used in England and France, and which estimates the effort by the diminution in height of a small copper cylinder compressed between the head of the piston and a fixed plane, is also an instrument of the same kind. And belonging to this class likewise is the apparatus based on the observation of the compression of a liquid, invented by Dr. Woodbridge and used in the United States. Finally, included in the same category are the numerous manometric apparatus, among which special mention should be made of the manometric balances of different types constructed for the French artillery and navy after plans by M. Deprez.

In the present article, however, it is proposed to dwell only on those instruments which are based on the second method of measuring pressure, and which have been termed dynamic. In applying this method, the piston submitted to the action of the gunpowder gases may be left absolutely free, and a determination of the law of the rapid motion which is communicated may be sought, either whether we content ourselves in measuring the velocity with which it is fired, or seek to register the spaces that it passes over as a function of the time. But it should be remarked that we may also profit by the fact that the projectile thrown by the gun is likewise a movable, the study of whose motion may allow the determination, by calculation, of the law of the succession of efforts that it has undergone. The gun itself, if it be allowed to recoil freely, is also a movable of known mass, but extremely heavy, whose motion also may serve for determining the pressures exerted on the bottom of the powder chamber. From thence was derived the idea of measuring the pressures developed on the gun by the determination of either the law of motion of the projectile in the chamber or the law of motion of the recoil of the piece. The first trials of the dynamic method were made in seeking to study the recoil of guns of the same caliber, but of different lengths; these were the experiments of D'Arcy in 1760, and were performed with the aid of a balistic pendulum. From that period, costly experiments

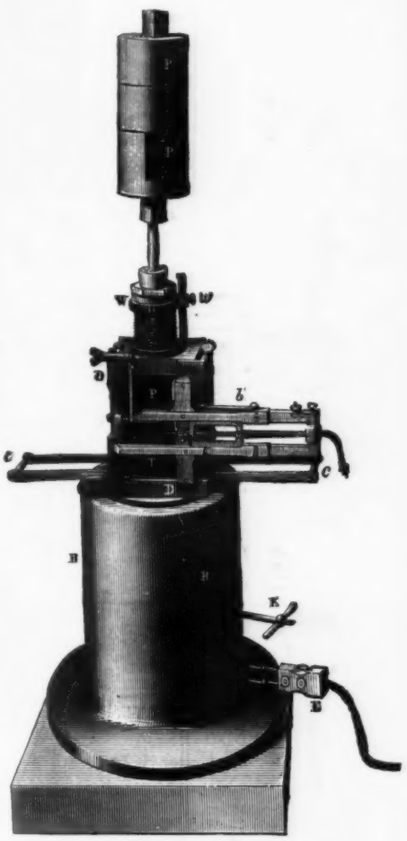


FIG. 7.—GUNPOWDER TESTER

have at various times been tried in successively cutting off lengths from the same gun, and measuring by the aid of ordinary balistic apparatus the velocities communicated to the projectile under identical conditions of loading. Complicated and delicate electric chronographs have also been constructed, and various arrangements have been invented for measuring the minute intervals of time taken by the projectile to pass over successive and given spaces of the chamber of the gun. Up to the present, these apparatus have not been given a simple enough form to make them serviceable in artillery experiments; but the time is perhaps not far distant when they will be made sufficiently practical. It only remains to speak of apparatus designed for registering the motion of small pistons freely shot by gunpowder gases, and which comprise the accelographs which it is proposed now to describe. The first trials made to study the motion of these pistons (which are small projectiles fired by what are really small guns affixed to the very gun submitted to experiment) were those of Cavalli, in Italy, 1845–60. The Italian general simply measured the velocity communicated to these projectiles by directing them against a balistic pendulum. Col. Bonfort, of the United States, and Gen. Neumann, of Germany, repeated these experiments in varying the conditions, but without adding to them any essential modifications. The question was in this state, when, in 1872, M. Marcel Deprez proposed a means of registering the very law of the motion communicated to the piston fired by the gases, and presented to the artillery service of the navy a project of an apparatus that he called the *Accelograph*. This instrument, which has within itself all the parts necessary to its operation, is easily manageable, portable, and convenient to use, and will now be described. It has already been constructed in several different forms which differ only in details from the one proposed by M. Deprez. The apparatus, it should be stated, may be either applied to a gun or adapted to a closed metallic chamber designed for the study of the combustion of powder in confined situations. We will first describe the apparatus as mounted on a chamber, and which has received the name of "gunpowder tester." This tester (Figs. 1 and 7) consists of a movable steel chamber, A, of three very thick walls, within which the powder to be tested is caused to detonate. As a measure of precaution this chamber is incased in a bronze jacket, B, which is provided with a screw cap, C. On this jacket is mounted the frame, D, of the accelograph properly so called. The steel chamber, A, is closed by two screw plugs, V and V', which are so arranged as to render leakages of gas impossible. To effect the latter object the perfectly adjusted ends of the plugs are hollowed out into reservoirs, the beveled sides of which may undergo, through the effect of the pressure of the gases, a certain amount of expansion, and fit so much the more exactly against the sides of the cylindrical spaces that they are designed to close in proportion as the pressure is higher. A screw cock, K, allows the gases to be collected for the purpose of analysis. The lower plug, V', is traversed by a piece of steel in the shape of a truncated cone, which is prolonged into a cylindrical rod electrically insulated from the body of the plug by a covering of gold-beater's skin which is affixed to it by shellac. This conical steel supports in the interior of the chamber, by means of a prolongation in the form of a clamp, the end of a very fine platinum wire, the other extremity of which is fixed to a like clamp communicating with the body of the apparatus. This wire raised to red heat under the action of an electric current, which enters through the conductors, F and F', sets fire to the charge of powder with which it comes in contact.

Through the upper plug is drilled a cylindrical opening, into which is accurately fitted the piston, *p*, whose motion is to be registered. This piston is prolonged through the cap of the bronze jacket, and its upper extremity is screwed into a cubical piece, T, which slides in the rectangular frame, D, supported by the cap, and which may itself be surmounted by additional cylindrical weights, P and P'. The piston and the cube surmounting it thus form a movable mass of known weight, which is capable of being freely displaced by the action of the power developed by the gunpowder gases, but only, however, within the limit of the travel permitted by the height of the frame which serves as its guide. In the upper surface of the cube is embedded a rubber buffer which abuts against a screw, W, of large diameter and carrying the frame at its upper portion. The shock resulting from the stoppage of motion is thus thereby deadened.

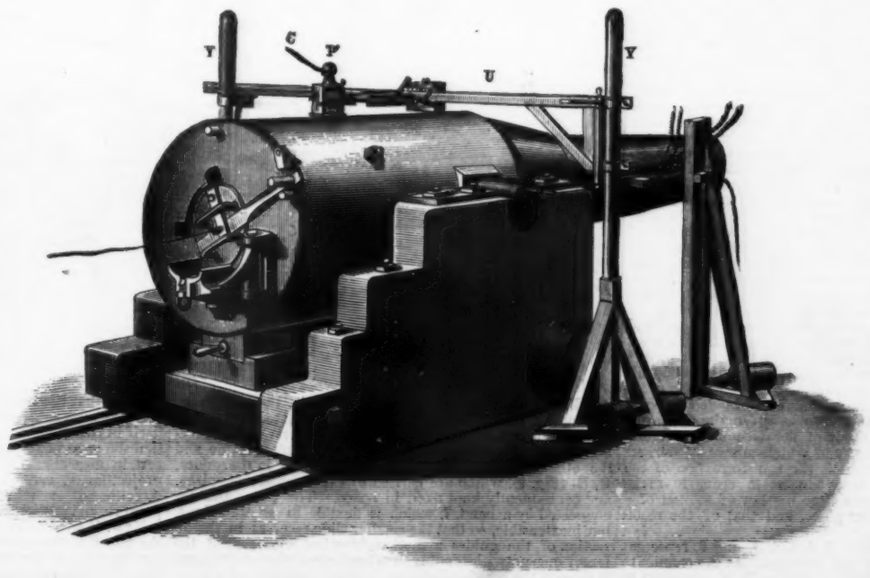


FIG. 8.—ACCELOGRAPH MOUNTED ON A CANNON.

As it is the law of motion of the piston, or rather of its surmounting cube, that is to be registered, there is affixed to one of the faces of the cube a small, square steel or thick glass tablet covered with a layer of lampblack. In front of this tablet is arranged a small slide, S, which carries a style in the shape of a small, flexible, finely-pointed steel pen. The slide runs between two parallel rails, R R, arranged horizontally; and, in this movement, its style traces a horizontal line on the tablet, and at the upper portion of the latter if this be supposed to be immovable in its initial position. The slide is caused to move through the action of a quickly-acting drag spring, which, in the apparatus represented in Figs. 1 and 7, is nothing else than a tightly attached strip of rubber. As will be explained further on, the exact law of the motion that the slide assumes under

the influence of this spring is known beforehand. At the beginning of each experiment it is held at the extreme end of its travel by an apparatus which is so arranged as to set it free at the precise moment that the piston itself begins to move under the action of the gases; thus the two motions—that of the piston and that of the slide—which take place in rectangular directions, have a strictly common and simultaneous origin.

When the apparatus is designed to be used on a gun (Figs. 3, 4, 5, and 6) the frame of the accelograph is mounted on a steel plug, V, which is screwed into a hole bored perpendicular through the walls of the powder chamber, and which is traversed by a cylindrical channel in which is accurately adjusted the piston, *p*. The arrangement of the slide and tablet is the same as in the preceding case. In both cases, according to this arrangement, if we suppose that the piston alone is displaced (the slide remaining fixed) the style will trace on the left side of the tablet a vertical line that it will have passed over in following the very law of the motion that it is a question of determining. If, on the contrary, we suppose the piston immovable and the slide set free, the style will trace on the upper portion of the tablet a horizontal line that it will have passed over according to a known law of motion. If the two motions take place simultaneously, their composition will give rise to a trace in the form of a regular curve directed toward the angle formed by the two preceding right lines, which will serve as co-ordinate axes; and, if the abscisses and ordinates be measured with precision (the horizontal abscisses being able to give the durations of the style's passage, since we know the law of its motion), we will have the vertical travels of the piston which correspond with these known durations, and, consequently, we shall be able to set off by points the curve of the spaces passed over by the piston as a function of the time. The readings are effected by means of a microscope with filar micrometer, which is carried by a slide that may be displaced according to two rectangular axes, and that is put in motion in each of these directions by means of a micrometer screw. Readings may thus be made to a hundredth of a millimeter. It now remains to show how the simultaneous starting of the piston and slide is effected, and how the law of motion of the latter is determined.

In order to make sure of the starting of the slide at the moment of the first displacement of the piston, it is held at its starting point by means of an appendage, L (Figs. 5 and 6), in the form of a thin horizontal plate, which prolongs it on the side opposite the spring, and which engages between two plane faces belonging to two small projecting metallic pieces, one of which, N, is carried by the fixed frame of the apparatus, and the other, M, by the cube which surmounts the piston and forms a portion of it. This plate is squeezed between these two pieces by the weight of the piston, and held there until the latter is raised. In order to ascertain the law of motion of the style, calculation might be resorted to, but greater precision can be obtained by the use of a special chronograph, composed simply of two uprights, between which falls as freely as possible a weighty mass, on which may be fixed the very tablet that is to be placed on the accelograph. To the lower part of the uprights are affixed horizontally the guides which direct the slide of this apparatus, they being so arranged that the tablet in its fall passes on a level with the guides and meets the style of the slide. At the top of the uprights is placed a click which holds the slide at its starting point, notwithstanding the tension of the rubber band, and which is disengaged at the very moment of the tablet's passage, so as to allow the style to move. Thus there is obtained on this lampblack-coated tablet a curve starting from one of the lower angles and assuming nearly the form of a branch of parabola. As we know from the law of falling bodies the velocity acquired by the tablet at the moment of the passage of each of its points before the style, we can evidently determine by points, by setting off with the micrometer the abscisses and the ordinates of points regularly spaced on the curve, the law of the horizontal motion of the style that we desire to know. By means of this arrangement, then, we register for each experiment, and upon the same plate, the curve which makes known the law of motion of the style, as well as that of the piston; and the first of these curves is obtained at the very moment the gun is fired. Thus are eliminated the errors that might proceed from changes in the physical conditions of the apparatus, and it is this that allows of the use of bands of rubber, in spite of the sensitiveness of that material to atmospheric influences.

Finally, to obtain a registration of the effects of the powder during various durations of time, in spite of the limited travel of the piston, the motion of the latter may be made slower either by varying its section submitted to the gases, or by loading it with additional weights, P', which are placed on the upper surface of the cube through the intermedium of the metallic rod, P, which penetrates the screw serving to regulate the travel of the piston. When the apparatus is mounted on a cannon these weights are left free; they are then thrown up to a height of six or ten feet, when the piston, arriving at the end of its travel, is suddenly arrested in its motion. When the apparatus is mounted on a powder-tester these weights may, as shown in Figs. 1, 2, and 7, be guided by a vertical rod which traverses them. They may then be made to displace along the rod a small copper slide which preserves a record of the height which they reached, and thus allows a calculation to be made of what the velocity of the piston was at the end of its free travel. Thus we have here a control over the operation of the apparatus. It is well to provide the lower weight, as shown in the figures, with a Dobo click in order to prevent the masses from falling back on the apparatus too violently. Another control of the apparatus is obtained by a vibrating slip of metal, G, placed on one of the sides of the fixed frame, and carrying a pen which traces on the tablet undulations that are designed to make known those displacements of the piston which correspond with successive durations of time—each equal to a half period of the vibrations of the slip.

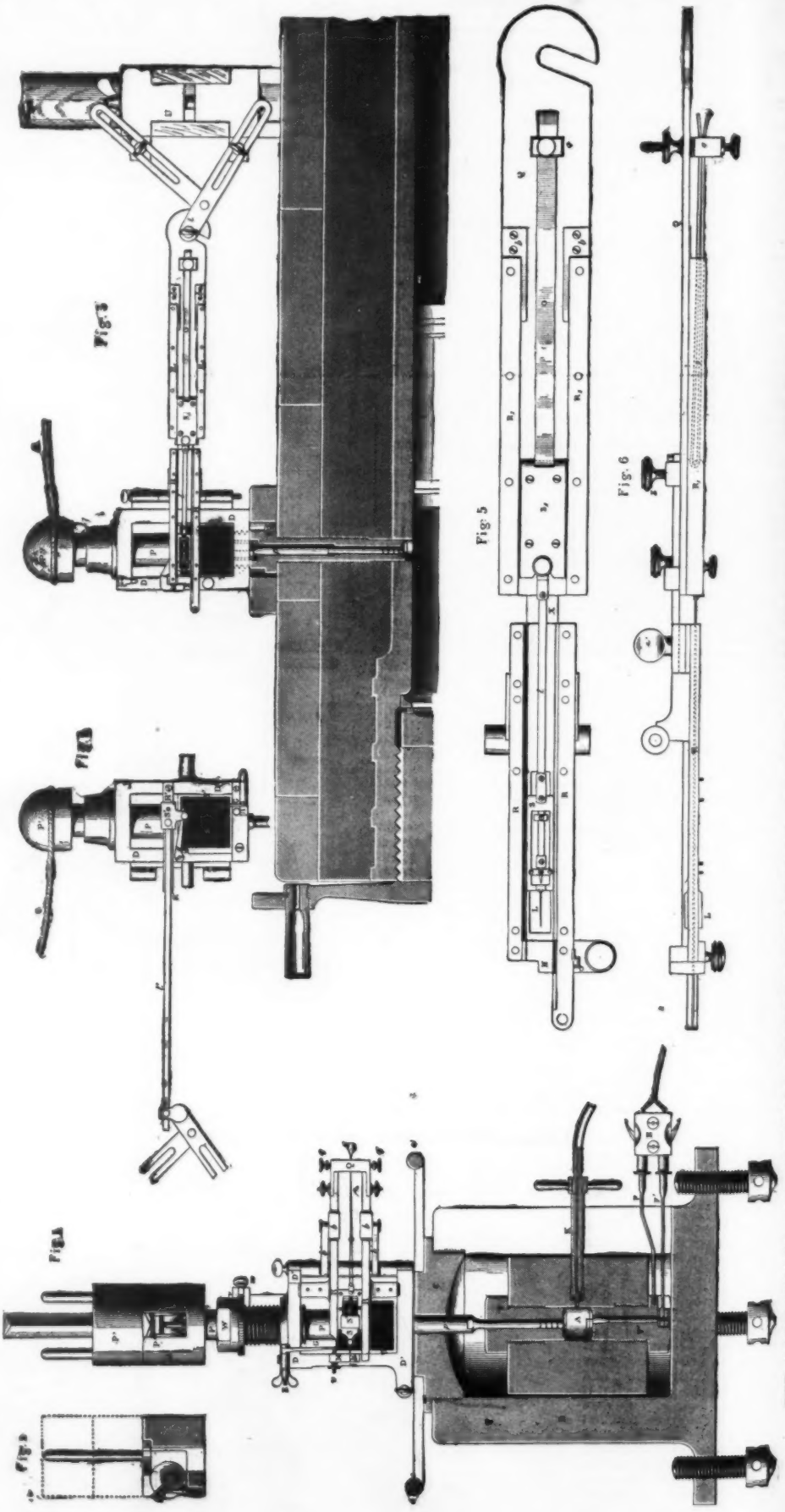
The traces made by the accelograph are very sharp and very regular, and permit of readings being made with great precision by the microscope; and the apparatus furnishes important elements of appreciation for a comparison of different powders or of different modes of loading.

Before closing this article, it will be of interest to point out a special arrangement that may be given the apparatus when it is applied to the study of the phenomenon accompanying the firing of guns, and which allows of curious results being obtained. This is the transformation of the accelograph into a double apparatus in order to make known at one and the same time the law of motion of a piston fired by gunpowder gases, and that of the recoil motion of the gun.

The accompanying figures, 3, 4, 5, 6, 8, and 9, represent the apparatus arranged for this purpose. As the cannon in recoiling may have a tremulous motion, it is expedient to make the fixed style describe a straight line in its relative motion, and for this reason it is mounted (Fig. 4) on a small slide, S', which moves along a grooved rod, R', carried by the frame of the accelograph. To keep it fixed in the groove it is connected by a rod, *l* (which is inextensible, but flexible in all directions), to a horizontal wooden cross piece, U, which is supported by two fixed uprights, Y Y (Fig. 8).

If, however, the slide arranged as in the preceding case were retained, with the point of attachment of the tensile spring connected with the accelograph itself, it might happen that the motion of the slide, whose law is supposed to be known, would be disturbed by those effects of inertia of the slide and spring which are produced by the sudden recoil motion of the gun. This danger is obviated by making the slide in two parts, one of these being very light, carrying the pen, and sliding in the guides fixed on the frame, and the other, S', being much heavier and sliding in the guides, R, R, (Fig. 9), which are carried by the wooden cross-piece, and consequently kept fixed in space. The two slides are connected by a band, *l*, which is flexible in all directions, but inextensible, so that the smaller slide receives in the direction of the guides a motion identical with that of the larger one, notwithstanding the vibrations of the cannon; and it is upon the heavier slide that is fixed the stretched spring, O, which calls forth the motion. The apparatus thus arranged gives two curves; the one made by the slide moved by the spring has its abscisses or co-ordinates horizontal, and these are at each instant the sum of the displacements of the slide in space and of the horizontal displacements of the cannon in its recoil motion; the other has abscisses which are equal simply to these latter displacements. An examination of these two curves affords a practical experimental demonstration of a fact which, as extraordinary as it may appear now, formerly gave rise to long controversies among artillerymen, and that is the question as to whether a cannon recoils before the projectile has left it. The immutable principles of mechanics indicate that the cannon must begin its recoil movement at the very moment that the projectile commences to displace itself in the chamber; and even if we leave out of consideration the mass of the gunpowder gases (which, however, to a certain measure invalidates the results), we may say that the projectile and cannon must displace themselves in inverse directions at each instant by quantities that are inversely proportional to their respective masses.

Now, if we consider the curve traced by the fixed style on the tablet of the accelograph, and which makes known the law of recoil of the cannon, it is evident that if the piston arose without the cannon recoiling, the style would, all the



THE ACCELOGRAPH, FOR MEASURING PRESSURES DEVELOPED BY GUNPOWDER GASES, AND FOR STUDYING THE LAW OF RECOIL OF CANNONS.

time, describe the vertical axis of the ordinates; and if, on the contrary, the cannon recoiled before the piston began its movement, the style would describe a portion of the horizontal axis of the abscisses before beginning to trace a portion of the curve. Now in reality we always find that the trace of the style, forming the curve of recoil, detaches itself clearly and mathematically from the very angle formed by the meeting of the two axes, thus demonstrating that the recoil commences precisely at the moment when the piston (and consequently the projectile) begins its motion; and this takes place even in rifled cannons whose projectiles are provided with bands which are forced into the grooves; although it might have been expected that in these cannons the piston, which is free in its socket, would rather have begun its movement a little before the projectile.

It is hardly necessary to point out all the applications that may be made of the accelograph. It need only be said, in conclusion, that it can evidently be employed in the observation of other phenomena than those attending the combustion of gunpowder. It has, for example, already been used for measuring the variations of pressure that take place, at the moment of firing, in the cylinders filled with water and

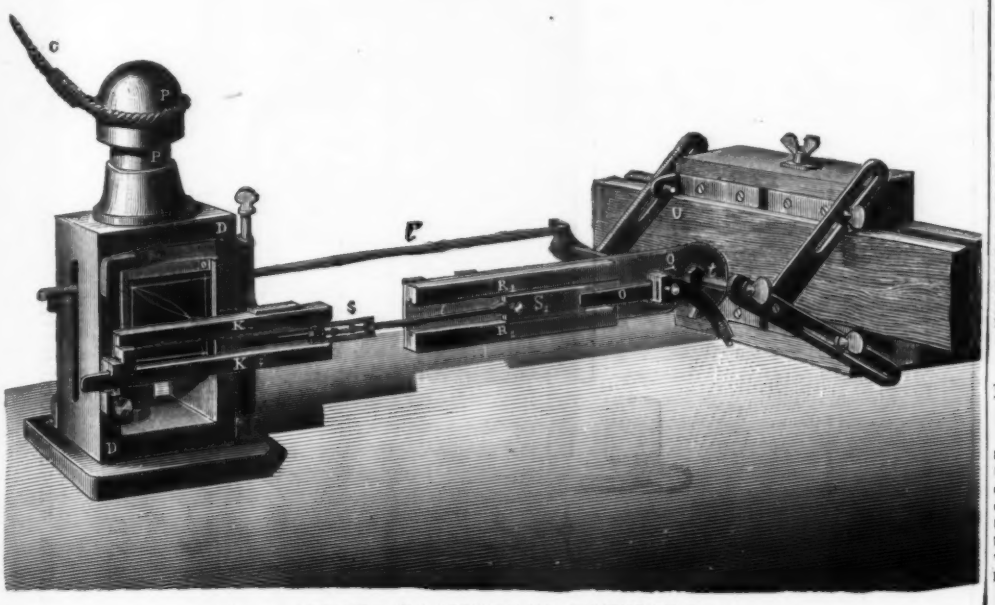


FIG. 9.—DETAILS OF APPARATUS SHOWN IN FIG. 8.

THE ACCELOGRAPH.—AN APPARATUS FOR MEASURING THE PRESSURE OF GUNPOWDER

air, or water alone, which serve as brakes in the new hydraulic carriages for guns of large caliber.

In all these applications for measuring pressures suddenly developed it has the advantage over the ordinary manometric apparatus in use in being able to register rapid oscillations of pressures, this being something that the latter are powerless to accomplish. But it gives these pressures only in an indirect way and by the aid of delicate readings and pretty long calculations.

RAISING SUBMERGED VESSELS.

CONSIDERABLE ingenuity has from time to time been brought to bear upon the subject of raising sunken ships and other submerged objects. The latest, but by no means the least ingenious, of the numerous inventions for effecting this object is that devised by the Rev. Cowell Brown, of Ellesmere Road, Sheffield, who is the inventor of the "Nautilus" apparatus, a very simple and efficient means of saving life from drowning. Mr. Brown's present invention relates chiefly to a special means of inflating apparatus for raising submerged objects. Hitherto it has been proposed to use airproof bags under water, the bags being inflated by air, and in some cases by gases generated in the bags themselves by bringing together certain chemical substances, or by the admission of a small quantity of fluid down a tube leading to the bag or vessel containing the chemicals, or by liquefying the gas and liberating the liquefied gas into the vessels. The costliness and uncertainty of these methods, in deep water, led Mr. Brown to the use of combustible compositions for the purpose.

A suitable composition is gunpowder, or a mixture of nitrate of potash, nitrate of soda, nitrate of baryta, or other oxygen-bearing substance, and carbon, together with some such substances as red ocher, whiting, or glycerine. These, on combustion, give off a definite volume of gas, which is used for inflation. The purpose of the whiting or red ocher or glycerine in the composition is to regulate the speed of combustion. If four parts of nitrate of potash, one of carbon, and one of whiting be used, the resultant gas is mainly carbon monoxide, which is lighter than air, and has not been liquefied, and the speed of combustion is not too quick. If sufficient nitrate of potash is employed, the resultant gas is principally carbon dioxide. But carbon monoxide is preferable because: (1) It is lighter than the other; (2) its evolution is accompanied by less heat; (3) it can be used under great pressure, without liquefaction. Four parts of nitrate of potash, with one of carbon, slightly moistened with glycerine, is also a suitable compound; likewise gunpowder ground into a stiff paste with glycerine. Where large quantities of gas are required, as in the case of floating docks, coal dust and nitrate of soda may be employed. The mixture may be fired by electricity, percussion, or time fuse.

Figs. 1 and 2 of our engravings show the apparatus for inflating flexible pontoons. It consists of a spherical chamber, *a*, with a metal tube, *b*, screwed into it, as shown in section at Fig. 2. This tube, *b*, contains the combustible charge, and is closed water-tight by a cap, *c*; *d* is a plug of non-conducting material through which the wires pass; it is secured by a cap, *e*, which screws on to a hollow projection on the tube, *b*. The flexible pontoon to be inflated is connected to this apparatus by the nozzle, *g*. On the ignition of the charge the evolution of the gas instantly commences, and the hot gas evolved is rendered perfectly cool by coming in contact with the inside surface of the chamber, *a*, and with the water tube, *l*, which passes through the chamber. The tube, *h*, is provided with a safety valve, *m*, so that the surplus gas may escape without the fear of the bag or pontoon bursting.

In displacing water contained in submerged rigid buoys or pontoons to which Mr. Brown's apparatus is connected for the purpose of raising submerged bodies, the pontoon being first connected to the vessel by chains or ropes, he uses the apparatus shown in section at Fig. 3, and in which *a* is the gas chamber, *b* the tube containing the combustible composition, and which is so secured to the cover of the chamber, *a*, that it can be readily removed for recharging. This buoy and its attachments are lowered to the submerged object by the opening of a cock or valve, *n*, on the top of the vessel, *a*, whereby the air is released from it, and water enters at the lower part, and so the apparatus sinks. The water is prevented from entering the perforations, *v*, by a waterproof band, b^2, but which gives way on the firing of the charge. The buoy being connected with the submerged structure which is to be raised, the cock, *n*, is closed, the current from the battery is transmitted, and the composition ignited. The gas being evolved passes out through the perforations, *v*, in the tube, *b*, and at the upper part of the chamber, *a*, displacing the water. The buoy will consequently exert a lifting power proportionate to its displacement. The superfluous gas (should there be any) escapes at the lower end by the water.

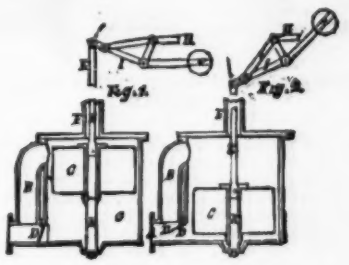
A convenient apparatus, specially adapted for the lifting of large objects, is shown in transverse section at Fig. 4, where *a* is the shell of the iron vessel, or lighter; *b* the combustible composition chamber, having perforations at the upper part which may be closed against the admission of water in any convenient way; *o* are doors or clacks at the bottom, opened by rods, *p*. The advantage of this apparatus is that it puts large lifting power into a form which allows of convenient handling. The vessel, or lighter, shown in section, may be sailed or towed to the place where it is required, and sunk upon or near the object to be lifted.

Submarine engineers who have had experience of rough-surfaced and swift waters will appreciate the advantages of a system which enables them to place the lifting-power close to the work to be done, and which, besides this, substitutes the electric wire for the flexible hose and pumping engine. We understand that a number of practical experiments have been carried out with Mr. Brown's invention, which have proved both its practicability and utility, thus giving hope of its commercial success. We may add that Mr. Brown has also patented the application of his system to the propulsion of torpedoes, the same being effected in a manner as ingenious as his other inventions.—*Iron.*

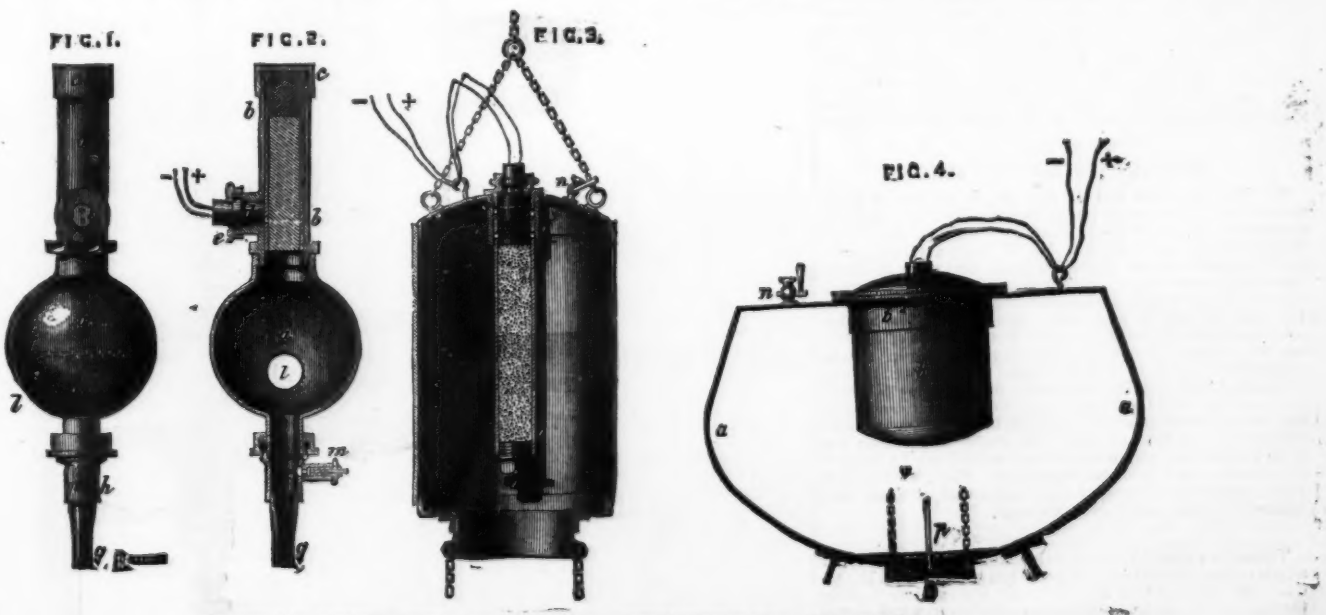
GOVERNORS FOR MARINE ENGINES.

By W. T. CLARK, Rugby, and W. H. ASHWELL, Bedford, England.

FOR marine purposes the improved governor consists of a cylinder which is in direct communication with the sea through an opening in the stern of the ship. Within the cylinder is an inner vessel connected by a rod to levers or cranks for working the throttle valve of the engines, so that while the water outside the ship covers the blades of the propeller the cylinder is filled with water, and the inner vessel being thereby raised, the full pressure of steam is admitted to the engines; but when the vessel pitches and the



propeller emerges, the water in the cylinder will run off and the inner vessel will descend, thereby imparting a pulling motion to the rod which closes the throttle valve and stops the supply of steam to the engines; the object being to prevent the "racing" of the engines when, from the pitching of the ship, the propeller is temporarily relieved from work. There are two arrangements described for effecting this part of the invention, and another arrangement applicable for stationary engine governors. The illustration shows the cylinder and inner vessel referred to. The port, A, is open to the sea, and the water entering therein closes valve, D, and passing up port, B, fills the cylinder and causes the inner vessel, C, to rise on its guide, K, and impart an upward stroke to the rod, E, thereby com-

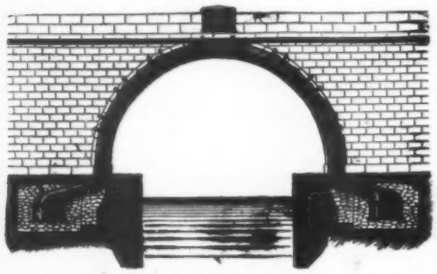


APPARATUS FOR RAISING SUBMERGED VESSELS.

municating the opening motion to the throttle valve through the crank, I, and connecting rod, H. When the sea recedes from the propeller the water escapes from the cylinder by valve, D. For governors for stationary engines a current of water is forced by a rotary pump beneath a piston weighted by a spring or weight, the piston rod either imparting direct action to the throttle valve or operating the slide valve of a steam or hydraulic cylinder for the same purpose.

SIPHONS FOR SEWERS.

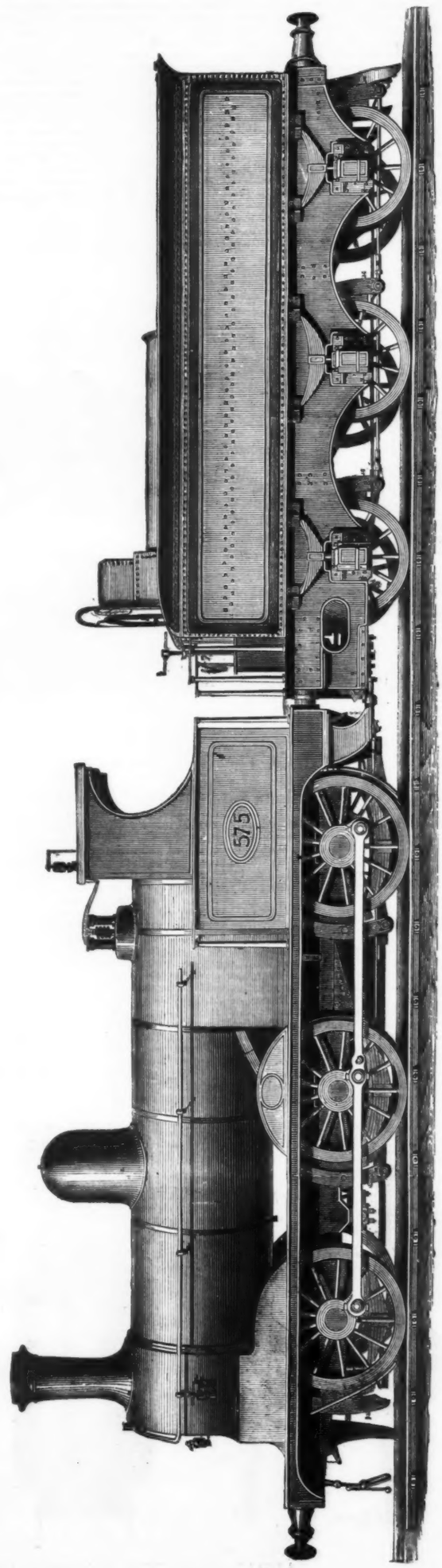
IN the construction of sewers, it is often necessary to carry them through water-courses. Hitherto there has usually been employed for this purpose an immersed siphon on a system proposed by M. Belgrand. But this arrangement, in addition to the trouble and expense attending all constructions under water, has the grave inconvenience that, although it does very well for clean water, it is apt to get choked up when used for sewage purposes, owing to the deposition of solid matters in the lower parts of the inverted siphon. A new solution of the difficulty has recently been devised by M. Lévy, engineer in chief of Ponts et Chaussées, Paris, and described by him in a paper communicated to the French Academy. It became a question of leading the sewage waters from Bercy to the other side of the Canal Saint-Martin. For this purpose, M. Lévy constructed a true siphon *over* the stream, and one in which by a peculiar arrangement, it is impossible for solid matters to accumulate at any point whatever. This siphon is a tube of large diameter backed with masonry and exhibiting nothing peculiar in its construction, the interest and novelty connected with it being the method adopted to keep it charged. At the top of the siphon the pressure is only one-fifth atmosphere, and consequently the disengagement of the dissolved gases is quite notable, and had not tromps been utilized to draw these off the siphon would have emptied itself very rapidly. The tromps used are actuated by the city water, which, at this point, has a very strong pressure. As well known, these apparatus, which are now frequently used in laboratories, permit the rarefaction of air or gases to be carried to a high point. A preliminary experiment with a tromp of suitable size showed that it would draw off the quantity of gas disengaged during a flow of two cubic centimeters per second. For the sake of greater security, however, M. Lévy constructed three tromps which were capable with certainty of keeping the siphon charged, even during a flow greater than the normal one. When the flow reaches a certain amount, however, recharging is no longer necessary, the velocity with which the liquid flows being amply sufficient to draw along the gases naturally. As it is useless to keep the tromps in constant operation, since their action is only necessary when it is feared that the siphon is about to empty itself, M. Lévy devised a valve which is capable of being moved automatically by a float. This valve, when the quantity of gas disengaged is small, closes the orifice of the tromp, and opens it when the quantity becomes great enough to stop the operation of the siphon. By this ingenious arrangement a great saving is effected in the use of water. Although there are three tromps, one is sufficient to keep the siphon charged, the three together being set in operation only when the siphon has become emptied by any cause whatever. As it was feared that the sewage waters containing solid matters in suspension might be sucked into the tromps and thus obstruct them, a chimney was constructed to a height of thirty-four feet above the level of the canal and closed on every side, and at the top of this is located the tube which puts the siphon in communication with the tromps. As even in a perfect vacuum water can rise only to a height of thirty-four feet, there is no fear that the suction pipe will ever be entered by the matters above mentioned. The siphon here described has now been in operation since the 10th of last March, and has thus far worked satisfactorily. The engineering problem which has been solved here is of course applicable only in cities provided with a supply of water having considerable pressure.



SEWAGE SIPHON OVER THE CANAL SAINT-MARTIN.

SIX-COUPLED LOCOMOTIVE.

WE illustrate here one of fifty goods engines recently ordered by the Lancashire and Yorkshire Railway Company, constructed by the Vulcan Foundry Company, Newton-le-Willows, from the designs of Mr. W. Barton Wright, locomotive superintendent, Lancashire and Yorkshire Railway. The cylinders are 17½ in. diameter, with a stroke of 26 in. The wheels are 4 ft. 6 in. diameter and the wheel base 15 ft. The grate surface is large—19½ square feet. The heating surface of the tubes is 943½ square feet, and that of the fire-box 90½ square feet—total, 1,034 square feet. In sixteen engines the boiler is to be of Lowmoor, and in sixteen engines of Bowling iron, and the remainder may be made of either one or other. The inside fire-box and the stays to be of copper; the tubes are to be of iron with 6 in. of solid copper tube brazed on at the fire-box ends. The tender is peculiar; it is fitted at the front end with Sharp's patent arrangement of cab, tool box, and filling hole combined. The wheels are 3 ft. 1¾ in. diameter; the engine and tender will be fitted with Hardy's vacuum brake.—*The Engineer.*



SIX-COUPLED GOODS ENGINE, LANCASHIRE AND YORKSHIRE RAILWAY.

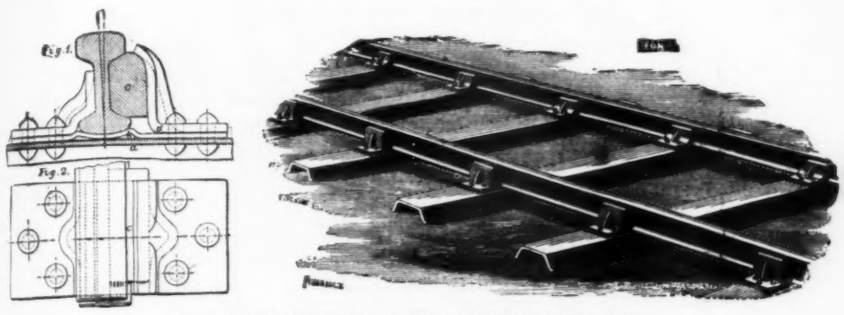
CONSTRUCTED BY THE VULCAN FOUNDRY COMPANY, NEWTON-LE-WILLOWS, FROM THE DESIGNS OF MR. W. BARTON WRIGHT, LOCOMOTIVE SUPERINTENDENT, LANCASTER AND YORKSHIRE RAILWAY.

THERE is a tree in Virginia called Mountain Mahogany, of a rich red color and very hard. When used for fuel it produces such intense heat as to burn out stoves more rapidly than any coal. It blazes as long as ordinary wood would last, and then becomes converted into a sort of charcoal that lasts twice as long as ordinary wood.

IRON RAILWAY SLEEPERS.

We give illustrations of a system of iron and steel permanent way, of which some experimental lengths have been laid on the London and Northwestern Railway, namely, half a mile on the down main line in Anglesey, half a mile on the up Chester line near Beeston, and a short length opposite the steel works at Crewe.

This system of permanent way, which has been designed and patented by Mr. F. W. Webb, the chief mechanical engineer of the London and Northwestern Railway, consists of trough-shaped sleepers, having riveted to them chairs of the form shown in Figs. 1 and 2. In the case of the permanent way so far laid down the sleepers are of iron, and were rolled by the Ebbw Vale Company, while the chairs, which are of steel, were made at Crewe from the crop ends of rails. To make the jaws of the chairs the crop ends are first rolled into ribbons, and then stamped up into shape, the



WEBB'S STEEL AND IRON RAILWAY.

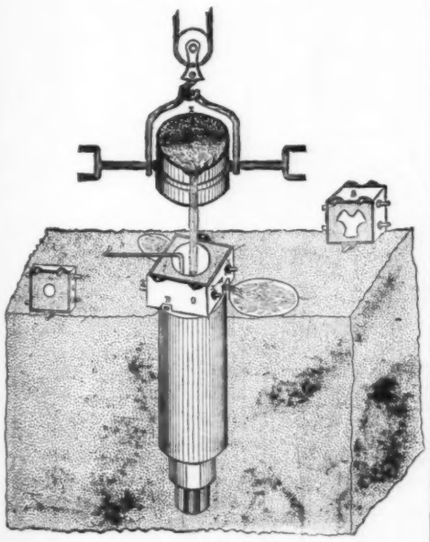
operation being performed very rapidly. All holes are punched to template, each end of a sleeper being punched at one operation. The riveting is done by hydraulic power, and the chairs have shown no signs of working.

It will be noticed that each chair is made up of two jaws and a packing piece which forms the immediate bearing for the rail, so that any working of the latter will not injure the sleeper. Between the sleeper and packing and the packing and chair jaws there are interposed strips of pasteboard, paper, or canvas, dipped in tar or asphalt. To give rigidity to the jaws they are bulged in the middle of their width, as shown in Figs. 1 and 2, and this bulge forms a recess on the inner side of the jaws into which the compressed wood key swells. So far there has not, we are informed, been one case of a key working out. On the London and Northwestern the keys are always put outside the rails so as to form a cushion to resist the blows of the wheel flanges. Mr. Webb's permanent way is a thoroughly good mechanical job, and the experience with it has so far been highly satisfactory.—*Engineering.*

BURNING OR MENDING HEAVY CASTINGS.

By THOMAS D. WEST.

THE principle employed in the process herein described for burning a new neck and wabbler upon the end of a broken cast iron roll, such as are used for rolling iron, steel, and other ductile metals, may, with a display of moderate skill and judgment, be practically applied for turning or mending a variety of heavy broken castings.



PROCESS OF MENDING HEAVY CASTINGS.

The object of this process is in mending heavy castings to avoid the expense of making new ones, and, if properly performed, it is very economical and will save much time, labor, and expense.

The most essential points to be observed in mending heavy castings by this process, are as follows: The melted iron must be very hot and of a medium soft quality, for the hard iron chills quickly, and therefore does not perfectly cement or unite with the broken surface of the casting.

An outlet must be provided to allow the melted iron to escape from the mould as soon as it is poured in, particularly at first, as the hot metal is liable to chill. The hot metal should fall directly upon the surface of the fracture, and, after beginning to pour, a uniform steady cutting stream of iron should be kept flowing from an elevation as high as possible. In burning the neck and wabbler upon a roll, the larger the roll the more successful will be the operation, on account of the larger surface for the melted iron to burn or cut into, thus uniting more perfectly.

As a preliminary operation, the roll should be made as hot as possible in the foundry oven, after which it should be lowered into a hole, previously dug in the foundry floor, keeping the broken end even with the level of the floor, as shown in the engraving upon this page, after which the hole should be quickly filled with sand, rammed up solid, particularly around the top of the roll. The surface of the fracture should be chipped all over, so as to break the skin of the metal and remove the rust.

The wabbler and neck must be moulded in dry sand, for if made in green sand the falling melted iron would cut the moulds all to pieces. These moulds should be made in section, as shown in the illustration, where 2 represents the mould for the neck, and 3 the mould for the wabbler, while 4 is for the riser or feeding head.

The flask, 2, has three places cut out at the bottom edge, A, B, C, which are for openings to allow the melted iron to freely escape while the neck is being burnt on. As soon as the roll has been securely placed, the flask, 2, should be put in position, care being observed to keep the opening for the neck exactly in the center of the roll to allow for turning up the journal in a lathe. Pigs of iron or other suitable heavy weights should be placed upon the handles, X X, to hold down the flask. If an air furnace is used in the foundry three basins should be formed, one opposite each of the openings, A, B, C, to catch the waste iron, but if there is no air furnace at hand, then a pig bed should be made, throwing the spare sand around the joint between the roll and flask so that there can be no run-out. The sand should be cleaned away from the outlets, and runners made leading to the places formed for catching the waste iron. If the iron should be likely to run upon the face of the roll at the outlets, it should be smeared with oil at those points to prevent the melted metal from adhering to it. In commencing to pour the iron the ladle should be held very low, and then gradually raising the ladle until the metal will have a fall of about four feet. The ladle is supposed to be handled by a requisite number of men not shown. The man in charge of the process can easily ascertain if there are any places upon the surface of the fracture where the melted metal is not cutting, by means of the bent rod, D, and the molten stream directed upon those places. Some small pieces of tin or zinc should be kept at hand, and by constantly throwing them into the mould, the iron in the holes that are burnt is thereby made hotter than it would be otherwise.

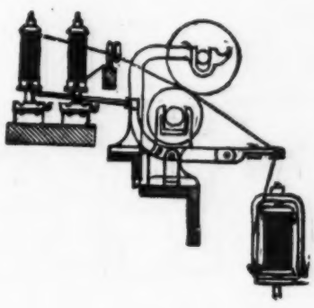
The iron should be poured until only about five hundred pounds remains in the ladle; the openings, A, B, C, should then be stopped with a stopping stick and clay, then fill the neck nearly full of metal.

The protecting ring (which is a thin plate of metal, having a hole in the center, the same size as the neck, and is placed on top of the flask to prevent the falling stream of molten iron from cutting away the edge of the mould) should be lifted off at once by means of handles attached to it; then skim off all the dirt and slag from the surface of the metal, after which the wabbler mould, 3, should then be quickly placed upon the flask, 2, and the feeding head, 4, upon the top of the flask, 3. These flasks should be securely held by placing heavy weights upon the top, after which the mould should be quickly filled and fed with metal, until it solidifies. If the neck has been burned successfully, the old or original neck will be the first to break. In regard to the amount of iron necessary to complete the operation described, I may say, that it depends entirely upon the nature of the casting to be mended. For a roll weighing from 5,000 to 7,000 pounds, it will take about 1,800 pounds for burning on wabblers or neck, while on small rolls, about 1,200 pounds of metal will be required. The cost of the process is comparatively small, and saves the trouble and expense of turning up a new roll, besides effecting a great saving in time, which is a very essential point in rolling mills.—*American Machinist.*

APPARATUS FOR PREVENTING WASTE IN TWISTING AND DOUBLING YARNS AND THREADS.

By J. CLOUGH, Haincliffe, Yorks, Eng.

UPON each creel peg is a tube carrying a pegged braid to support and engage with the bobbin from which the yarn is being drawn, and a toothed wheel which can be held by a detent or detecter wire. The yarns to be doubled are led through the feed rollers in the ordinary way, but in the place of the usual thread eye, a balanced lever is used, one



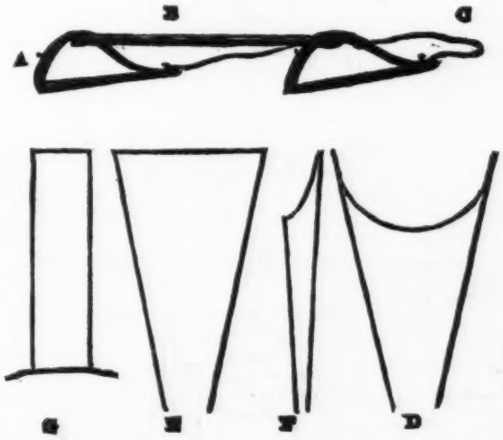
end of which forms the thread eye, and the other the detent. As long as the yarn is being wound by the flier, the "drag" depresses the lever, and keeps the detent clear of the toothed wheel, but when the yarn breaks the lever rises, and the detent engages with the wheel, and stops the rotation of the creel bobbins, thereby preventing the formation of a "roller lap;" 1, 1 are the creel bobbins, 8, 8 the toothed wheels, 9, 9 the balanced lever, 12 the doubled yarn.

HOW TO MAKE A TRAWL.

MR. THOS. E. PARKINS writes as follows to the *Sea World:* In regard to the turbot, I have often caught the young fish in the Harbor of Beaufort, which I take as evidence of the larger fish being on our coast, also the brill, sole, and plaice. I have no doubt that a little further north these fish abound in great numbers, and with a good fishing smack, or a steamer, I think, would be better than a sailing vessel, for a trial, as they could move on different ground, or from place to place, and would be more likely to find the fish quicker with a steamer, and, as the writer says, a large fishing business could be established. I think the idea a good one of sending to England for a set of trawl heads and beam, with ground rope already fitted and the net. Then any one used to making nets could make one after the pattern. But I think the trawl could be made all complete in this country, also that there could be many good trawlers found in the United States who could take charge of that department.

It is not a very hard job to make a trawl. Any blacksmith can make the trawl heads. The beam is of oak or ash. Any good netter with a little instruction could make the net.

I send you a rough outline of the different parts of a trawl as used by the Barking fishermen, which are marked



HOW TO MAKE A TRAWL.

as follows: A, trawl heads, 5 feet long on the tread and from 3 to 4¼ feet high; B, the beam; C, the ground rope—it is leaded and then covered by winding another rope tight around it; D, the ground or belly of the net; E, the upper or back of the net; F, the two wings or sides of the net; G, the cod end—it is of double twine, and put on after the back, belly, and wings are laced together. It is made in two straight pieces, and laced at the sides so as to form a sort of sack, with a draw string at the extreme end. The fishing smacks from Barking carry four men and from three to four boys.

[A private letter from Professor W. K. Brooks, of Johns Hopkins University at Baltimore, says that Mr. Parkins is an experienced trawler, and is thoroughly well posted.]

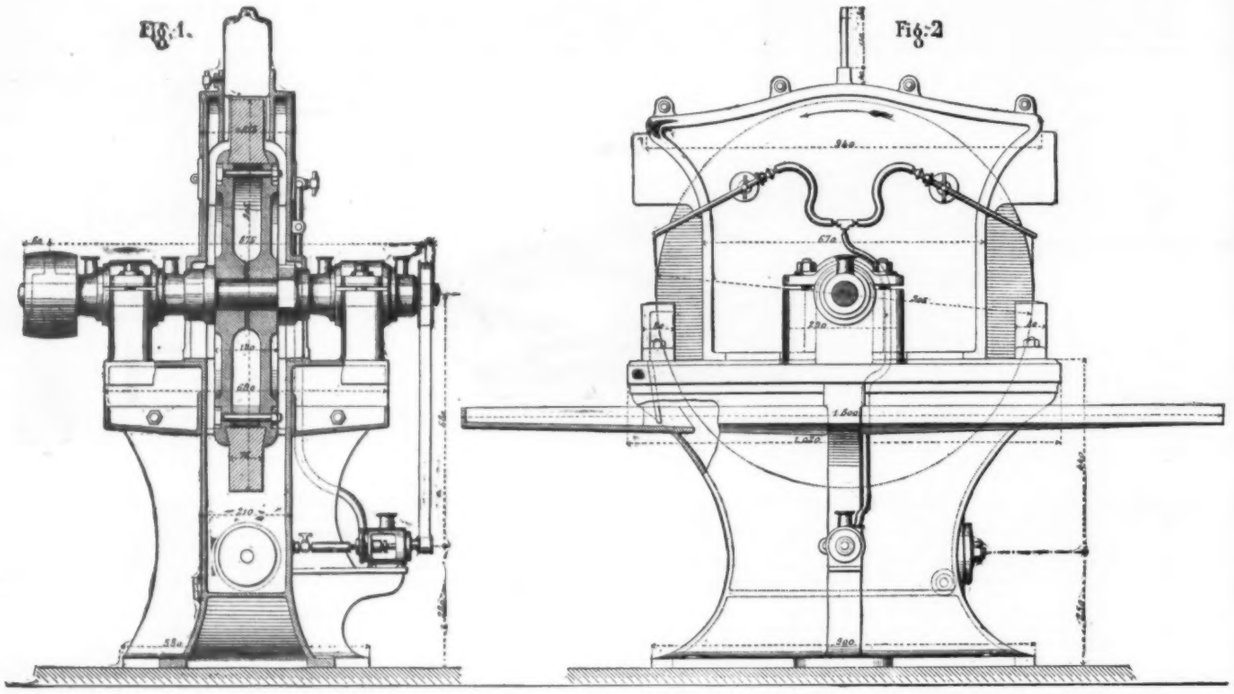
EMERY MACHINES FOR SHARPENING TOOLS.

THE emery machines of Messrs. Thomson, Sterne & Co., of Glasgow, are widely employed by English artisans for sharpening tools and polishing metals, and are now likewise being rapidly introduced on the continent. They are extremely hard, do not foul, and may be used indifferently dry or very wet when tempered tools are to be sharpened. In the accompanying figures are represented some of the different types of these machines for tool grinding.

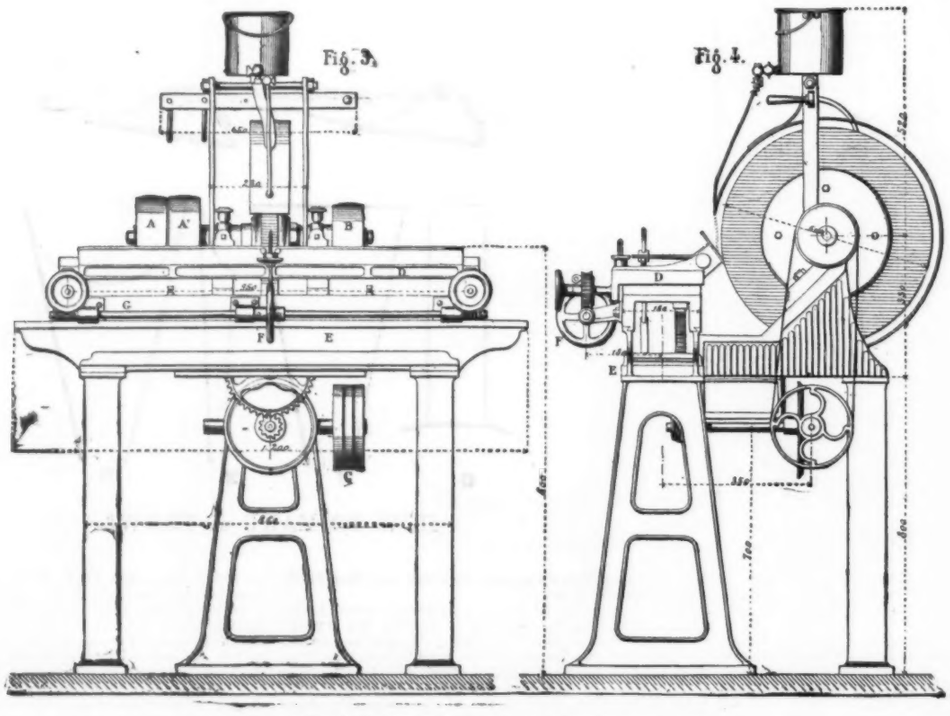
Machine for Grinding Large Tools.—Figs. 1 and 2 represent a machine designed for use in shops where large and coarse mechanical work is done, and where it frequently becomes necessary to sharpen tools of large dimensions. The wheel, which can be used either from the front or from behind, owing to the symmetrical form of the frame, is three feet in diameter by three inches in thickness. In order to preserve the temper of the tool during the process of sharpening, there is fixed to the side of the frame a small centrifugal pump, which draws water up from a reservoir located in the base, and forces it into pipes which allow it to fall on the edge of the grinder through small apertures made for that purpose. This machine requires a separate driving wheel, with loose and fast pulleys of eight inches in diameter. The velocity of the driving shaft is 170 revolutions per minute.

Machine for Automatically Sharpening Cutting-blades.—This grinder, Figs. 3 and 4, is constructed for the purpose of automatically sharpening plane blades of all kinds for cutting such articles as paper, leather, tobacco, etc. The wheel is twenty inches in diameter and one and a half inches in thickness. The driving pulleys, which are separate from the machine, are eight inches in diameter, and have to have a velocity of 270 revolutions per minute. The shaft of the wheel carries three pulleys. Two of these, A and A' (one of which is loose and the other fast), are actuated by the general power, and the third, B, carries a belt running over one of the three pulleys, C, only one of which (the middle) is loose, as usual in planing machines. The blade to be sharpened is fixed on a carriage, D, which is mounted on the bed, E, of the machine like the slide-rest of a turning-lathe. This carriage carries at its lower part a rack which engages with a toothed wheel put in motion by the pulleys, C, by means of bevel wheels and pinions. When the carriage, carrying the tool, arrives at the end of its travel, and consequently has caused the entire length of the beveled edge of the blade to come in contact with the wheel, an automatic uncoupling pushes the belt on to the other fast pulley, C, and the gearing wheels then turning in an opposite direction cause the carriage to return to its initial position. During the grinding, when it becomes necessary to remove the tool from against the wheel, the operator turns, by hand, a small hand-wheel, F, which commands the slide mechanism. The water necessary for the wheel is furnished by a small reservoir placed above. The wheel of this machine, as well as that of the preceding, has the form of a crown, that is, it is hollowed out in the middle and is held on the axle by two strong cast iron rings which are bolted to the wheel. This arrangement possesses the advantage that it permits of the wheel being almost entirely used up.

Universal Emery Grinders.—The first of these machines (Figs. 5 and 6) is employed in shops for sharpening tools of all kinds, such as gravers, cross-cut chisels, scissors, planes, etc., etc. The wheel is twenty inches in diameter and two and a half inches in thickness. It is mounted on rings, and the water is furnished by a centrifugal pump, which draws it from a reservoir formed in the base of the frame. The frame carries the driving apparatus and the gearing. It is



EMERY GRINDER FOR LARGE TOOLS.



AUTOMATIC EMERY GRINDER FOR CUTTING-BLADES.

EMERY MACHINES FOR SHARPENING TOOLS.

Fig. 5.

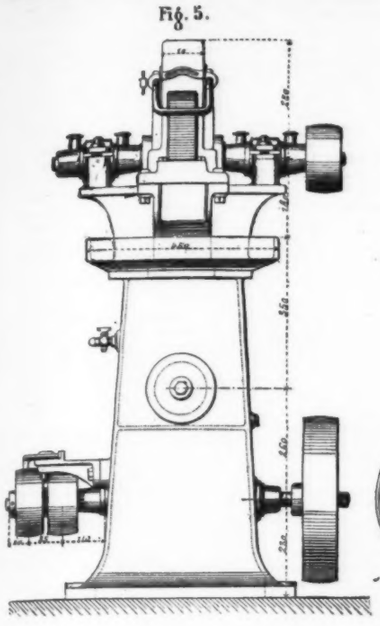
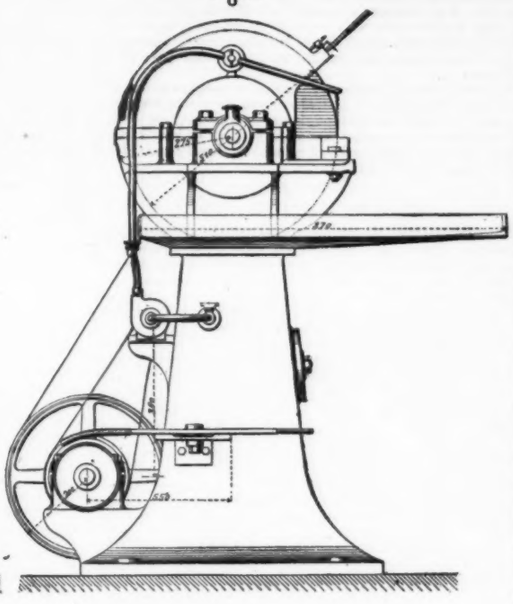


Fig. 6.



UNIVERSAL EMERY GRINDER.

EMERY MACHINES FOR SHARPENING TOOLS.

necessary for the shaft to revolve with a velocity of 300 revolutions per minute. The machine represented in Figs. 7, 8, and 9 is constructed more especially for sharpening wood-working tools in the shops of carpenters, joiners, etc. It has six wheels, fourteen inches in diameter and from one-half to two inches in thickness. Two of these have a flat surface for grinding scissors, planing irons, adzes, etc., while the four others have a rounded edge for sharpening gouges, the irons of joiners' planes, etc. One of them has a very fine grain, so that it may be used as an oil-stone.

THE DISCOVERY OF UNDERGROUND SPRINGS.

From the French of DANIEL RAMÉE.

WATER is a necessity for construction, in preparing mortar and for other uses. A proprietor is often embarrassed unless he has some means of ascertaining whether the site on which he wishes to build offers an accessible supply of the fluid which is indispensable to the work which he contemplates. It is therefore useful to have in mind certain principles of the art of tracing underground veins of water.

Every one knows the definition of valleys—depressions of considerable width, which extend from a mountain ridge downward, usually ramifying into several branches, and ending at some river; of defiles, or gorges, which lie between the spurs of the mountain chain; of ravines, the narrow and deep passages, formed usually by a stream of water; and finally, of gullies, or longitudinal depressions of slight depth. The slopes which inclose these different varieties are called the flanks of the valley, gorge, ravine, or gully. The usually sinuous line of intersection where the two sloping flanks meet at the bottom is called in German the *thalweg*, or the path of the valley, indicated in Fig. 1.

In those dales and valleys which have no visible watercourse at the bottom to indicate the line of greatest depression, the true *thalweg* can be determined by careful study of the path which such a stream would take if it existed. This line must be ascertained with great care, as it is of the highest importance in fixing the position of springs.

Valleys have a mutual relation to each other which should be understood. Every principal valley forms a main trunk, ramifying into branches, or lateral gorges; each lateral gorge ramifies in its turn, receiving a large number of inferior depressions, which again branch more or less.

FIG. 1.

The wide spaces, apparently horizontal, which are called plains, really present also low ridges, or watersheds, branching variously, and between them slight depressions, forming shallow valleys, in which water courses often wind. Although at first sight it may not be apparent in what direction the plain is inclined, by a little attentive observation the general slope can be detected, and also the various basins and depressions, with their ramifications.

So much may be said of the superficial conformations which it is necessary to study; but beneath the surface may exist a variety of conditions not less important. By stratification in geology, is understood the arrangement by successive layers of the different sedimentary deposits which have taken place, one after the other, whether these consist of recent alluvium, or have, in the course of ages, hardened into beds of rock. Each of these layers differs in thickness, density, constitution, and color from those above and below it, and as the surface of the primitive mass upon which they were deposited presented irregularities—elevations and depressions—so the beds of the sedimentary rock, clay, sand, or gravel follow the inequalities of the underlying body. Among the alluvial or stratified rocks are included many kinds of limestone, slate, sandstones, and other hard or soft mineral substances which lie in well-defined beds, whether horizontal or inclined. Granite, chalk, tufa, porphyry, and many other rocks which present no division into layers, or only a very faint one, are called unstratified. The stratified layers rest as a rule upon a mass of unstratified rock of indefinite extent, which is often buried under many successive beds of sedimentary deposits. If the layers had always been left undisturbed, they would form a continuous covering to the unstratified rocks, consisting of a greater or less number of concentric coats, but continual movements are taking place in the interior of the earth, by which the deeper lying rocks are pushed up in some places and sink in others, and these movements of the inner mass disturb and break up its stratified envelope, sometimes tearing it asunder in deep clefts, sometimes pushing up separated edges until the layers are turned vertically. The character of the stratified layers varies exceedingly in different places. Sometimes the primary rock is bare, or thinly covered with sand, clay, gravel, or other alluvium; sometimes it is buried thousands of feet below many beds of alternating stone and softer substance. Hence it follows that the rain which falls on the earth is received by surfaces of very various powers of absorbing it. Clayey grounds, or tracts of bare unstratified rock, are nearly impervious, and the water is obliged to run off over their surface, or to collect in pools in the hollows. Into other soils, on the contrary, such as gravels, sand, or loam, with such rocky masses as present numerous seams and crevices, the water sinks immediately, continuing to descend until it meets with an impenetrable stratum, above which it collects much in the same way as if the hard layer had formed the original surface. If this inclines also, the water runs downward over it, just as it would over a sloping rock above ground, only somewhat more slowly.

Thus the innumerable streamlets which are formed by rain on the sides of mountains and hills of permeable surface run partly over the grass toward the valleys, and partly sink into the ground until they meet an impenetrable stratum. The strata in such situations usually keep a direction parallel, or nearly so, to the surface, and the water which reaches an impenetrable layer flows down over it in the same direction as that which runs over the grass above. Often the upper soil is so absorbent that all the water that falls on it sinks in immediately, and the streams in which it descends the slope are entirely beneath the surface. Whatever may be the nature of the ground, the water which falls on it, except the small portion that is lost by evaporation, finds its way, either above or below the surface, to the *thalweg*, or line of greatest depression. In every valley, gorge, ravine, gulley, or hollow, there is thus in rainy weather a watercourse either apparent or concealed. If apparent, it runs over the surface of the soil, because it is retained there by an impenetrable stratum; invisible, it exists none the less upon the surface of some impenetrable stratum beneath, covered from view by a layer too porous to be able to retain it at the top.

The commencement of a subterranean rivulet or spring is sometimes in an elevated plain, dry, slightly hollow in the middle, and a little inclined, sometimes at the end of a deeper valley, which forms a kind of amphitheater. When a spring rises in a mountain tract constituting a single basin, all the first streamlets of water converge to one center, at the lowest point. If the tract comprises several hollows of unequal depths, one can always be traced, deeper and longer than the others, into which they ultimately empty the streams which they collect.

In order to give an exact idea of the manner in which a subterranean spring is formed below any depression of the ground, it is only necessary to go to the spot during a heavy rain, and observe how the little rivulets of rain water unite

Fig. 7.

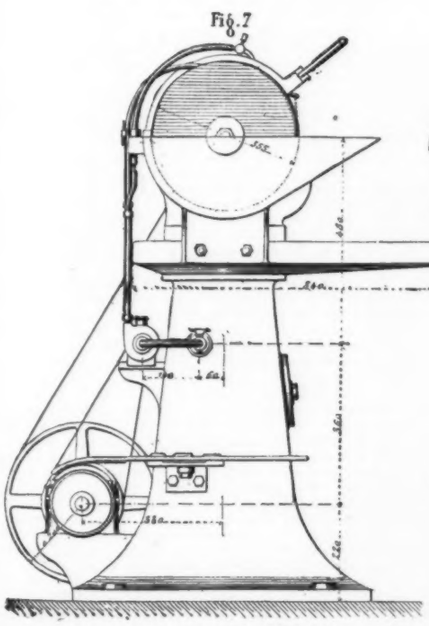


Fig. 8.

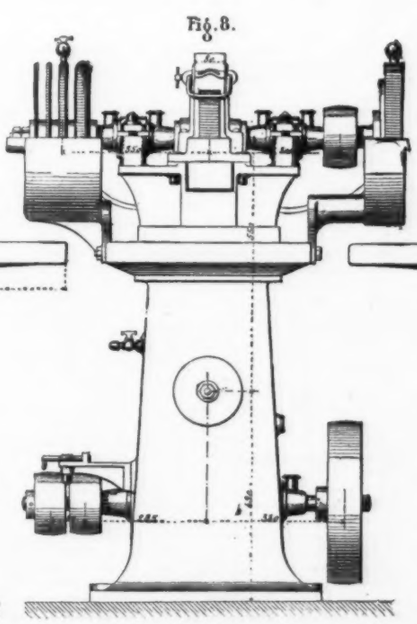
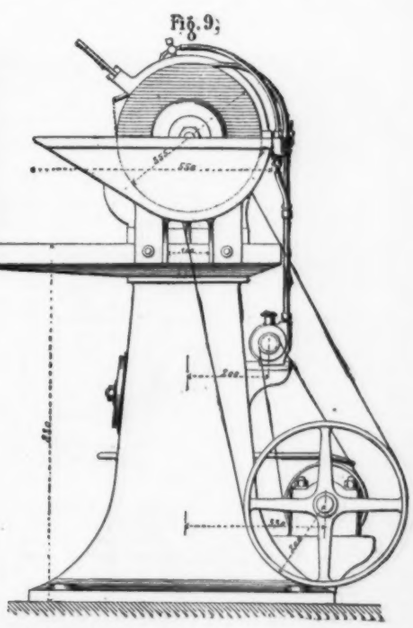


Fig. 9.



UNIVERSAL EMERY GRINDER.

EMERY MACHINES FOR SHARPENING TOOLS.

to form the watercourse which for a moment runs over the surface; it may be regarded as certain that the subterranean and permanent rivulets move beneath in the same manner, and that their tributary streamlets follow, in the ground, about the same lines as the superficial waters.

In dry weather, the collection, movement, and accretion of the rain water streams may be studied, in order to ascertain the formation of underground springs, by careful observation of the ground. When a spring rises at the end of a valley closed at the end, all the little veins of water which run down from the plateaus and slopes above converge nearly as the radii of a semicircle toward the central point of the basin, and there unite to form a spring. The center of such a basin is always at the foot of the steep semicircular slope which incloses it. From this point the *thalweg* begins, and the rivulet, proceeding from the spring at the head of the valley, follows this *thalweg*, or lowest line, however tortuous it may be, and whether the flow of water is above or below ground. From time to time lateral valleys contribute their streamlets, and the main current usually diverges a little at such points as if to meet these branches.

The subterranean brooks, not being disturbed by artificial constructions, or by excavations and embankments upon the surface of the ground, always follow the true valley bottom, which in many cases, does not correspond with the course which a surface stream would take, so that, in studying the course of the underground water, any alteration of the surface by artificial means must be noted, and a suitable allowance made for it, which can generally be done without difficulty. If it is desired to sink a well to reach water in a place where the visible bottom of the valley seems to have been changed by adventitious circumstances from its natural position, or where the lower part of the ravine is so filled up as to present a nearly absolute plain, the angle between the two inclined planes formed by the slopes inclosing the valley, should be observed carefully, and the watercourse will be found at their line of intersection. Thus, if the slope of the two banks is equal, the subterranean stream runs midway between them; if one bank is steeper than the other, the stream will approach the steep side in proportion to the rapidity of its slope; and if one of the two banks is a precipice, the concealed brook passes at its base.

The underground channel is also often indicated by temporary appearances of water on the surface. In many places, and always in rocky regions, a heavy rain is followed by an overflowing of the subterranean stream, which rises above its channel, just as a surface river overflows its banks. By observing the spots where the water first breaks out, and sinking a well there, a permanent supply may generally be found, and at a small distance below the surface. Every valley of some hundreds of yards in length, whether wide or narrow, rocky and dry, or nearly filled with alluvial soil, may be assumed with tolerable certainty to be traversed by a subterranean stream, whose course, however sinuous it may be, can be traced with sufficient accuracy by the means just described, and followed step by step.

It does not always happen, however, that all points upon the course of the stream are equally favorable for reaching it. The vertical distance from the actual surface to the water vein varies greatly, and the depth of a well dug at different spots would vary accordingly.

The points where the vein lies nearest the surface are:

1st. The central point of the first depression in the ground where the original streamlets are collected.

2d. The center of the amphitheater at the head of the valley.

3d. The foot of each slope in the line of the *visible* valley bottom.

4th. The approach to the outlet of the valley.

First.—When a spring commences in an elevated pasture land, the point where the water lies nearest the surface is that toward which all the primary brooklets tend which unite to form it. This point can be recognized by its position near the middle of the depression, and because the *thalweg*, or trough, is seen to commence there. If, descending the stream, a well is sunk at some point below, water will be found, perhaps more abundantly, than at the spring, through the addition of that brought by lateral tributaries, but it will lie at a greater depth, since the effects of cultivation, the accumulation of detritus brought down by storm waters, and other obstructions increase with the distance from the source.

Second.—When a spring rises at the extremity of a valley inclosed on three sides, the point where the water will be found at the least depth is in the center of the semicircle which forms the end of the valley. Lower down the trough it will be found by digging but at a greater depth.

Third.—In general, throughout the course of a subterranean stream, the points where it lies nearest the surface are found at the foot of descents. Ordinarily, the longitudinal slope of valleys is composed of meadows, level or slightly inclined, alternating with steep descents or land slides. These two kinds of surfaces are analogous to those presented by streams which display by turns rapids and deep pools. Whenever a ledge of rock, a stratum of compact earth, or even a wall, crosses a valley so as to form a dam, there will be above it a gently sloping meadow, formed by alluvium, and below it a steep descent, or dry cascade, which the action of the elements tends rather to erode than increase, so that the hard primitive substratum, and with it the water which flows over it, will be found with less depth of excavation here than in the places covered with foreign deposits.

Fourth.—Where a subterranean spring descends without too steep a fall toward a visible and permanent brook or river, water can always be found by digging near the point where the course of the spring would meet the river, and this water, in case the excavation extends below the river level, will generally be derived from the spring, and not from the river, although it may fluctuate in correspondence with the rise and fall of the river surface.

The most abundant springs, as well as the most easily accessible, are those situated at the foot of a descent, and this point should be approached as nearly as possible, even when it is itself inaccessible.

Under some plains, alluvial or otherwise, water flows in the form of thin sheets, no depression existing suitable for gathering it into a stream. In such places water can generally be found at any part of the surface, but in small quantities.

However, such grounds as a rule comprise several strata of different density, one above another, and each of the harder strata has its own sheet of water above it, so that if a well sunk as far as the first impervious stratum fails to reach water in sufficient quantity, a further supply can usually be found, by sinking deeper, until another hard layer is found, or even a third or a fourth. In general, also, these springs become more abundant in descending.

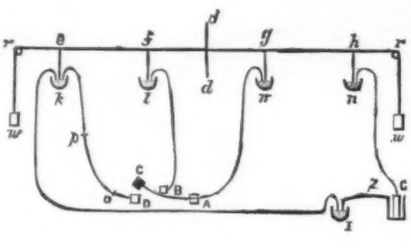
When a mountain or hill is terminated by a ridge, or by a peak, conical or rounded, no water will be found near its top, but if the summit is formed by a plateau, level or gently sloping, and covered with some depth of soil lying above an impenetrable stratum, it rarely happens that a spring cannot be found near the middle, or the lowest part of the plateau.

On the slopes of lofty and extensive mountains or hills copious springs are almost always to be found, but they should be sought on the gentle declivities covered with a thick layer of soil, rather than on the sides of steep, rocky cliffs, where, if they exist, they will be scanty and unreliable.—*Amer. Architect.*

THE MICROPHONE, 1880.

THE interesting experiments instituted by Mr. James Blyth, of Edinburgh, immediately upon the discovery of the microphone, appear to have directed the attention of scientific men in that city to microphonic research to a quite exceptional degree. "The Proceedings of the Royal Society of Edinburgh" for the past year, which are now before us, contain no fewer than six communications on this subject—called indifferently telephony or microphony, but which apparently are all microphonic. It is hard to say in some cases where microphony ends and telephony begins; but the earlier experiments here referred to relate chiefly to sounds produced by expansion and contraction under varying temperatures, or by loose points of contact, and are only indirectly connected with the special form of sound transmitter called a telephone. The several papers now published in the Royal Society's (Edinburgh) volume of proceedings are of such interest that we will endeavor to give our readers the substance of them in a single article—a separate reprint of them would far exceed the space we could afford.

As in the earlier instance, Mr. Blyth seems to have led the way to a new departure. Following up the experiments before alluded to, he succeeded* in producing currents by the friction of conducting substances, and then employed these currents for producing sounds in the usual manner. The currents so produced agree in direction with thermo-electric currents, and the greatest current is got, as might be expected, from antimony and bismuth. The mere rubbing of two suitable conductors in a circuit will produce sound in a telephone included in the same circuit; and this led Mr. Blyth to construct a small dynamo machine on that principle, consisting of a revolving cylinder of bismuth in contact with a plate of antimony. Wires led from these substances respectively, and, including a microphone and telephone, enabled him to hear sounds actuating the former just as in cases where a battery is employed. Acting on a hint suggested to him when using a sharp metallic point instead of



the horizontal plate, Mr. Blyth set about constructing a receiving telephone by means of a rotating bismuth cylinder, against which was pressed a fine wire, bent at right angles, and attached to the disk of a phonograph mouthpiece. Four Bunsen cells were put in the circuit, as also a microphone affixed to a violin, but no telephone. On playing the violin and rotating the cylinder the music was reproduced at the disk loudly enough to be heard all over an ordinary room. This effect is analogous to that of Edison's loud-speaking telephone; but, Mr. Blyth remarks, the explanation of their action must be different if electrolysis be the cause of variation in Edison's instrument, as no electrolysis takes place in Mr. Blyth's. Variations of the heat at the point of contact have a great deal to do with the actions of all microphones, Mr. Blyth thinks, and in general with all sounds transmitted from one loose contact to another.

In the following month† Professor Chrystal describes how he discarded the rotating thermo-electric arrangement, substituting the direct action of the current upon suitable thin wire attached to the membrane of a toy drum. We may here remark that Mr. Preece, in London, had hit upon the same device about the same date—perhaps a little earlier. Professor Chrystal's arrangements were almost identical with those of Mr. Preece‡ [*Electrician*, June 5, 1880], and we need not describe them in detail. Various wires were tried, but the best results were obtained with platinum and palladium silver. With the same wire the effect increased with the current strength, and, when producing a prolonged note, the wire burst into a bright glow, especially if the note was a high one. Heating the fine wire externally by means of a lamp increased the effect slightly, and cooling with water or a blast of air diminished it. Professor Chrystal also confirmed Dr. Ferguson's previous experiments, proving that these sounds may be produced by currents of very small total heating effect, such as induction currents, but differs from him in attributing the effect solely to heat. Some obscure molecular cause had been suggested by Dr. Ferguson, to which Professor Chrystal urges that it is not the *whole* heating effect that is in question, but its rapid *variation*.

At the next following meeting of the Society§ Dr. Ferguson replied, in support of his opinion, that the effect was not due exclusively, if at all, to variations of temperature, or, rather, in explanation of his holding that opinion. He held, with De la Rive, that the sounds were magnetic phenomena—that the molecules of the wire, in taking and losing the magnetic set, hit against each other, and emitted the sounds in question. As illustrating this view, though not entirely disproving that put forward by Mr. Blyth and Professor Chrystal, Dr. Ferguson arranged a very ingenious experiment, a diagram of which we give above. His chief objection to the thermal explanation was that the click which a wire emits when a current begins or ceases is inconsistent with the sluggish action of heat. This may be true for the click of a magnetic onset, but we think that Dr. Ferguson was wrong in saying that, unless the increments and decrements of length are momentary, they cannot affect a telephone disk. We know that the ordinary action of the telephone proves the contrary, for the currents then are not momentary, but continuous and undulatory. However, we give Dr. Ferguson's experiment following in his own words: "It struck me, on considering Professor Chrystal's reasoning, that if the sound be in the wire, the membrane disk, if placed in the middle instead of at the end of it, would still sound. If the sound was due to push and pull the two wires on either side would neutralize the effect the one of the other; but if due to internal commotion, little change would be observed. So far as I have been able to ascertain, the latter is the case: *w, r, e, f, g, h, r, w*, is a composite thread, consisting of a very fine platinum wire and fine cotton thread—*e f* and *g h* are the platinum parts. The thread is kept stretched by the two equal weights, *w, w*. The middle of the thread is attached to the skin or paper disk of an ordinary mechanical telephone, *d d*. At the ends of the platinum wires, wires of copper are soldered, which dip into mercury cups, *k, l, m, n;* and a six-cell Bunsen battery is inserted at *e z*. At i is a current interrupter or microphone, the one used in this instance being a mercury break vibrating some six times per second. A B C D is a key, the handle of which is resting against B, but is capable of being pressed down against D, and then disconnecting B. In the one case both the wires, *g h* and *e f*, are included, in the other only *g h—e f* being shunted off, a platinum wire, *p o*, being interposed to keep the resistance equal. We have here in the first case two opposing receivers on the extension theory, or two sounders on the internal click theory. In the second case we have a receiver, the same as that of Professor Chrystal. But the sound emitted by the disk is much the same in loudness when both wires sound and when only one does; if anything I fancy it is in favor of opposing wires. The two-pull telephone acts, in fact, as well as the single-pull; and so far as I can interpret these facts, it is something other than the *pull* of the wire that emits the sound, and the single-pull arrangement by no means proves the existence of sudden extensions and contractions in the wires. The conduct of a wire expanding instantaneously in every part may produce an effect like a molecular click, but, if so, its action must be something very different from the simple pull supposed."

Early in July Professor Chrystal again appears with some further facts mainly relating to the anomalous behavior of iron wires in these experiments. With other metals their variation of longitudinal extension, owing to heating, appears to be the explanation of their action in the wire microphone (or telephone). In soft iron wires the sound does not depend on their length and thickness, and other circumstances pointed to the suggestion that it is a consequence of their varying magnetism. Experiments with steel wires showed that when made white hot, and then tempered so as to deprive them of their magnetism, they were rendered incapable of giving off any sound; while on stroking them with a bar magnet they again emitted sounds quite distinctly. Similar experiments were made with nickel and with cobalt, and the effect of heating was in each case exactly what might be expected from their peculiar magnetic properties.

Consequent upon these disclosures Mr. Blyth was led to infer that a transmitter could be devised actuated solely by varying magnetism produced in a wire when caused to vibrate. His observations were communicated to the Society July 19,* and were substantially as follows: In his first experiments he employed a Bunsen battery of four cells. The wire to be subjected to examination being placed in circuit, a fine iron wire fifteen inches long was attached to it at right angles, the other end of which was affixed to the parchment disk of a mechanical telephone, and moderately strained. This was the transmitting arrangement, A. At the receiving station, B, an ordinary double-ear Bell telephone of small resistance was employed. It will be understood from this description that when the disk is vibrated, that portion of the circuit to which the disk is externally connected will vibrate also. When a fine iron wire nine inches long was the portion referred to any musical sound uttered into the mouthpiece of the mechanical telephone became distinctly audible at the receiving (Bell's) telephone, B. Speech could also be thus transmitted. Reducing the battery power was found to have little effect upon the intensity of the sounds reproduced. The battery was then removed altogether, with this startling result, that the sounds could still be heard, though now very faint. The reason for this effect appears to be that the vibrations of the iron wire across the lines of force, due to the earth's magnetism, produce a current strong enough to work a telephone. We are here reminded of the fact, first mentioned by Mr. Bell, that his telephone could be worked by a soft iron bar in place of the magnetized bar usually employed. But in Mr. Blyth's experiment, even this bar is dispensed with, and the magnetic variation is set up by the movement of a bit of wire in the circuit. This account of the phenomenon was confirmed by further experiment. The battery current was again introduced in the circuit, and a horseshoe magnet, with the line of its poles at right angles to the wire, was suspended over and quite close to it. A manifest increment of sound resulted from the approach of the magnet, and a decrement followed its withdrawal.

Mr. Blyth also noticed that in the case of fine iron wires inserted at A the sounds were transmitted equally well, whether the mechanical telephone was attached to the middle, as above described, or at the end of and in the same direction as the wire itself. This observation is of importance as confirming Dr. Ferguson's opinion that the effect is not produced by variation in the resistance of the wire, caused by the bending to and fro of its points of attachment to the circuit wires. Thick iron wire gave very faint sounds, but, on being heated by a flame to a dull red heat, the sounds became louder. One puzzling result, however, followed, for, on inserting first thick and then thin platinum wires, their behavior was the same as the magnetic iron wire. The same was the case with cobalt; while copper and aluminum gave rise to no sound whatever.

In explanation of some at least of these phenomena, Mr. Blyth suggests: "(1) Varying magnetization in the wire, especially the iron wire, caused by strain; (2) variation in the temperature of the wire, caused by the cooling effect of the air as the wire vibrates; (3) alterations of the resistance, caused by the varying strain to which a vibrating wire is exposed." Our readers will look forward with interest to the results of further experiments from the same quarter, and we shall give them publicity as soon as the information may reach us.—*Electrician.*

* "Proceedings of the Royal Society of Edinburgh," May, 1880.

† *Ibid.*, June, 1880.

‡ "Proceedings Royal Society," London, May 27, 1880.

§ "Proceedings Royal Society," Edinburgh, 1880, page 700.

* "Proceedings Royal Society," Edinburgh, 1880, p. 730.

THE AMERICAN FRANKLIN SEARCH EXPEDITION.

We have been favored with permission to make use of the interesting sketches and journal prepared by Mr. Henry W. Klutschak, of Prague, Bohemia, who was a member of the Arctic exploring party under command of Lieutenant Schwatka, of the United States Army, during the overland expedition to the shores of King William's Land, by which some interesting relics of Sir John Franklin and his comrades were lately discovered and brought to New York.

It will be remembered that in the year 1858 Admiral Sir Leopold McClintock, in Lady Franklin's little vessel, the Fox, wintered in Bellot Strait, Prince Regent's Inlet, and that in the following spring his limited sledge parties reached King William's Land, distant about 150 miles, where the first positive proof of the fate of the expedition was obtained; the remains of many of those who perished were discovered,

THE AMERICAN FRANKLIN SEARCH EXPEDITION: CROSSING SIMPSON'S STRAIT IN KAYAKS. FROM A SKETCH BY MR. H. W. KLUTSCHAK.

as well as various relics and records. Though the fate of the expedition was thus entirely set at rest, the search was necessarily a hasty and partial one, as the snow lay thick on the ground, and the parties had to return to their vessel before the disruption of the ice in summer.

For some years past reports have occasionally been received through American whalers which have wintered at or visited the northern parts of Hudson's Bay, and communicated with the natives, to the effect that books and other articles belonging to Franklin's expedition were known to exist in certain parts, and that the Esquimaux were willing to conduct the white man to them. In one instance, about three years since, it was positively asserted that some of the crew had crossed the Isthmus of Boothia, and reached a point on Melville Peninsula, in the neighborhood of "Fury and Hecla" Strait, and that relics of the expedition were deposited in a cairn there. Few persons, however, who were qualified to judge, believed that any of the crews had ever got beyond King William's Land, off which the Erebus and Terror were abandoned in 1848, or, at any rate, beyond the Adelaide Peninsula, which lies close to its southern end, and at the entrance of the Great Fish River.

We believe it was this latter report which principally induced Lieutenant Schwatka to undertake his remarkable enterprise. The American Geographical Society of New York, of which Chief Justice Daly is president, made arrangements, with a special fund subscribed in the United States, to fit out this expedition. The command of it was accepted by Lieutenant Frederick Schwatka, who is a cavalry officer in the Federal army; and it was joined by several volunteers, namely: Mr. William H. Gilder, who acted as special correspondent of the New York *Herald*; Mr. Henry W. Klutschak, an Austrian; and Mr. Frank Melms, of Milwaukee, Wisconsin; these gallant gentlemen served in the expedition without pay. As huntsman and interpreter and general assistant, the committee engaged Joe Eberling, of Croton, Connecticut, who had been with Hall's North Pole Expedition, and with Captain Tyson, and had distinguished himself in other Arctic journeys. The firm of Messrs. T. Morison & Brown, New York, liberally offered to convey the expedition to Hudson's Bay in their whaling schooner, named the Eothen. Accordingly, on July 19, 1878, the party under Lieutenant Schwatka's command sailed from New York, provided with all needful stores, arms, and ammunition, in such quantities and packages as would be suitable for a sledge journey overland. Early in August Lieutenant Schwatka, accompanied by three companions, landed near Chesterfield Inlet, of our charts, at the northern end of Hudson's Bay, with the provisions, stores, and equipments which he had brought with him, and formed his camp at a point named Cape Daly. He decided to pass the winter with the natives he found there, to assimilate his habits and mode of living as far as possible to theirs, and to persuade them to accompany his party in the spring in whatever direction he should decide to travel.

Lieutenant Schwatka soon found that the reports as to traces of the Franklin expedition having been discovered eastward of Boothia had no foundation in fact, and that they unquestionably referred to King William's Land; and there accordingly he at once resolved to proceed in the early spring.

On April 1, 1879, they commenced their journey, accompanied by thirteen of the Esquimaux, including women and children, and with three sledges and forty-two native dogs to drag them. On these sledges they carried about a month's provisions for the whole party, consisting principally of bread and meat landed from the whaler, and their equipment of firearms, which appear to have been of the very best description, and to which their great success in procuring game, and probably their personal security from the tribes of natives they afterwards fell in with, was mainly due. They crossed the country to the estuary of Back's River without any extraordinary difficulty, and found considerable quantities of game. They examined Montreal Island and the coast of the Adelaide Peninsula, met many natives from whom they procured relics of the lost expedition, listened to numerous anecdotes, more or less to be depended upon, and obtained what appeared pretty conclusive proof that one of Franklin's ships had drifted from off Cape Victory, where they had been abandoned, to a position within a few miles of the Adelaide Peninsula, or a distance of about 150 miles, where she was ultimately sunk.

The party in May, 1879, crossed over Simpson Strait to King William's Land, and commenced the search of its coasts. It would be impossible in this brief sketch to do more than touch upon the incidents of that minute search. They remained on the island five months, and scarcely a day passed that they did not come upon some relic of the sad retreat of our unfortunate countrymen. The coast had evidently been frequently visited by natives, who had disinterred those who had been buried for the sake of plunder, and left their remains to the ravages of the wild beasts. Lieutenant Schwatka and his party appear to have carefully reburied all these remains. But even during the summer it is with great difficulty that the soil can be removed for much more than the depth of a foot beneath the surface. It is probable, however, that what is left will now remain undisturbed.

During the summer and autumn of 1879 they made a complete search of King William's Land and the mainland adjacent, traveling over the route pursued by the crew of the Erebus and Terror upon their retreat towards Back's River. They buried the bones of all those unfortunates remaining above ground, and erected monuments to their memory. Their research has established the fact that the records of Franklin's expedition are lost beyond recovery. The Natchilli Esquimaux—who had found a sealed tin box about two feet long and one foot square, filled with books, at a point on the mainland near Back's River, where the last of the survivors of Franklin's party are supposed to have perished—were interviewed and questioned by Lieutenant Schwatka. These natives, it appeared, broke open the box and threw out the records, which were either scattered by the wind or destroyed by the children, who took them to their tents for playthings. This point was searched, not only by Lieutenant Schwatka's party, but nearly the entire Natchilli nation, inspired by a promise of a great reward for the discovery of any remnant of books or papers, no matter what was their present condition. None of the records were found, but the skeleton of a sailor was discovered about five miles inland. Every native who could impart any information was hunted up and interviewed, with the aid of a competent interpreter. It was ascertained that one of Franklin's ships drifted down the Victoria Straits, and was unwittingly scuttled by the Ookjoolik Esquimaux, who found it near an island off Grand Point during the spring of 1849. At that time one man was lying dead in the steerage, and during the same year the natives saw the tracks of four white men in the spring snows on the mainland. A large number of relics have been gathered by the party. From each spot where the graves were found a few tokens were selected that may serve to identify those who perished there. A piece of each of the boats found and destroyed by the natives has been brought away, together with interesting, though mournful, relics in the shape of the prow of one of their boats, the sledge upon which it was transported, and part of the drag rope upon which these poor fellows tugged until they fell down and died in their tracks. In addition to these they secured a board which may serve to identify the ship which completed the northwest passage. They have also brought the remains of an officer of the Terror, Lieutenant John Irving, which were identified by a prize medal found in his opened grave.

The narrative proceeds: "On our way back to Franklin Point we buried the skull found on our way up, but found no further bones till we reached Point le Visconte. We saw tenting places both of white men and natives at different points along the coast, and one cairn that had been torn down and contained nothing. At Point le Visconte we found the grave of an officer, as was evinced by the finding of gilt naval buttons among the debris and pieces of cloth and linen of finer texture than any seen elsewhere. There was nothing whatever to indicate the name or rank of the deceased, though we noticed that the grave had been made with especial care. This seems to have amounted to nothing, for it had been torn open by the savages, and the body dragged around by foxes and wolves. The bones that we found were scattered around, some of them a quarter of a mile from the grave; but as they were of different parts of the human skeleton, there was nothing to indicate that more than one person had been buried here. The care with which the interment had been made was sufficient evidence that the officer had died on the way from the ships. We found another empty grave on a hill where we encamped, about four miles below this point, and a skull about a quarter of a mile distant from it, evidently having been dragged there by wild beasts. The only things found in the tomb were a large brass buckle and a percussion cap. Near by were traces of native tenting places. In fact, wherever we found graves we always found evidences that natives had encamped in the vicinity."

The party, having successfully carried out the mission they had imposed on themselves, remained on the island until the ice was sufficiently strong to carry them back to the mainland, which was not until Nov. 1, the ice of the previous summer having commenced to break up on the west side of King William's Land at the end of July. On that day they recrossed the Strait, coasted along the west side of the Adelaide Peninsula, and selected a track for their homeward journey about sixty miles westward of their outward route. This winter journey occupied four months, instead of one month, as in the outward journey in spring; great hardships and privations were endured, owing to the extraordinary low temperatures and scarcity of food. Twenty-seven of their dogs died from hard work and starvation, rendering it necessary for the men to take their places at the sledges. On March 4, 1880, they reached their start-

THE AMERICAN FRANKLIN SEARCH EXPEDITION: REINDEER-HUNTING IN KAYAKS. FROM A SKETCH BY MR. H. W. KLUTSCHAK.

ing point at Cape Daly, and there remained till August 1, when they were taken on board the bark George and Mary, of New Bedford, and were brought safely home to the United States.

The sledge journey was the longest ever made through the unexplored Arctic regions, both as to time and distance, the party having been absent from their base of operations in Hudson's Bay eleven months and four days. During that time they traveled 2,819 geographical, or 3,251 statute miles. It was the only sledge journey ever made that covered an Arctic winter. The winter was pronounced by the Esquimaux one of unusual rigor, and the natives at Depot Island and Wager River suffered very severely both from cold and famine, the severity of the season precluding successful hunting. The expedition, however, withstood the greatest amount of cold ever encountered by white men in the field. On Jan. 3 of the last winter the thermometer sank to 71 deg. Fahrenheit, or 103 deg. below freezing point, and during the whole of that day it did not rise above 69 deg. During sixteen days the average temperature was 100 deg. below freezing point, and during twenty-seven days it was more than 92 deg. below. All this time the party pushed on; in fact, they never halted a single day on account of the cold. The storms came on in December, and, food running short, the travelers had to subsist on one meal a day, comprising at first about ¼ lb. of walrus or seal meat, but afterward of "kow," or the thick hide of the walrus, with a thick covering of hair. The party were without food for two days; during this time they mostly lay in bed to keep up the warmth, but fortunately some walrus and seal were killed. Throughout the entire journey their reliance for food was almost entirely on the resources of the country. It was the first expedition in which a white man voluntarily lived on the same food as his Esquimau assistants, thus showing that the white man can adapt himself to the climate, and travel as well as the natives.

As the open season drew to a close, the reindeer were to be seen in immense herds. On Sept. 23, 1879, a herd of fifty was encountered, and Toolooah, the Esquimau hunter, killed seven with a Winchester repeating carbine in less than ten minutes. On that day the different members of the party killed no fewer than twenty-six reindeer. (See engraving.) During some time the food consisted of reindeer tallow and meat, which was eaten, raw and frozen, for breakfast; the evening meal was generally made as warm as possible. Fuel was very difficult to obtain, and chiefly consisted of a species of moss. Reindeer tallow was used for a light, and a piece of fibrous moss served as a wick. The mean temperature for the month of September was 21·1 deg. F., and the lowest five deg. above zero. During October the mean temperature was 0 deg., and the lowest 38 deg. below zero; but, although the party wore only their woolen clothes and an overcoat, the cold was not very annoying. The temperature rose at noon to 32 deg. or 24 deg. above zero.

On Oct. 14 the ice was sufficiently strong for the reindeer to cross over to the mainland, and not a single one was seen after this. The mean temperature for November was 23·3 deg. below zero, and the lowest noted was 49 deg. below zero. The highest at noon was a little above zero. The salmon caught by the natives were remarkably large and fat.

During the summer the natives had found near Starvation Cove the skeleton of a white man and two pieces of his clothes, which indicated that he was a sailor, not an officer. On the 20th Lieutenant Schwatka observed a meridian culmination of the moon in latitude 67 deg. 32 min. 42 sec. It was very difficult to make astronomical observations with a sextant in a temperature 70 deg. below freezing point. The ice on the sextant glasses has to be removed by the warm finger, which in turn gets blistered, and it was a difficult matter to keep the glass in working order, as every substance had frozen. Sometimes the igloos or snow huts separated, and the breath of the occupants could be seen oozing at a distance of miles. The highest temperature in December was 26 deg. below zero, and the lowest 69 deg. below zero, or 100 deg. below freezing point. This was at noon on Dec. 28.

The party now began to be assailed by wolves, and Esquimau ingenuity was called into requisition to deal with the beasts. Equeesik, one of these people, made a trap in the following manner: He set two keenly sharpened knife blades covered with blood in the snow. These the wolves licked, at the same time slitting their tongues. The cold kept them from feeling the wounds at the time, and their own warm blood tempted them to continue till their tongues were scarified in such a manner that death was inevitable. The Esquimaux also got a strip of whalebone, and rolled it up in meat, which was held together by the frost until it was swallowed by the wolf, when the meat thawed, and the whalebone opening out, caused a most agonizing death.

On the western shore of King William's Land, where the Erebus and Terror were abandoned in 1847, these American explorers found some interesting relics of Sir John Franklin's party. They came upon the camp of Captain Crozier, and in a grave found a skull and some other bones; also a handkerchief and a silver medal, two and a half inches in diameter, with a bass-relief portrait of George IV., surrounded with the words "Georgius IV., D. G. Britanniarum Rex, 1820;" on the obverse, and on the reverse, "Second Mathematical Prize, Royal Naval College," inclosing the words "Awarded to John Irving, Midsummer, 1830." This identified the remains as those of Lieutenant Irving, the third officer of the Terror; and Lieutenant Schwatka brought them to New York, and entered into correspondence with the Admiralty, with reference to their transmission to this country. In answer to a communication from the Admiralty, the Anchor Line Company asked to be allowed the privilege of bringing over the remains to this country. The offer was accepted, and the box containing them was handed to the captain of the Circassia, which brought them to Glasgow. They were consigned to Lieutenant Colonel Irving, a brother of the deceased, at present residing in England. It was arranged to inter the remains in Edinburgh, the native city of Lieutenant Irving. The funeral ceremony lately took place there, with naval honors, in the Dean Cemetery. —*Illustrated London News.*

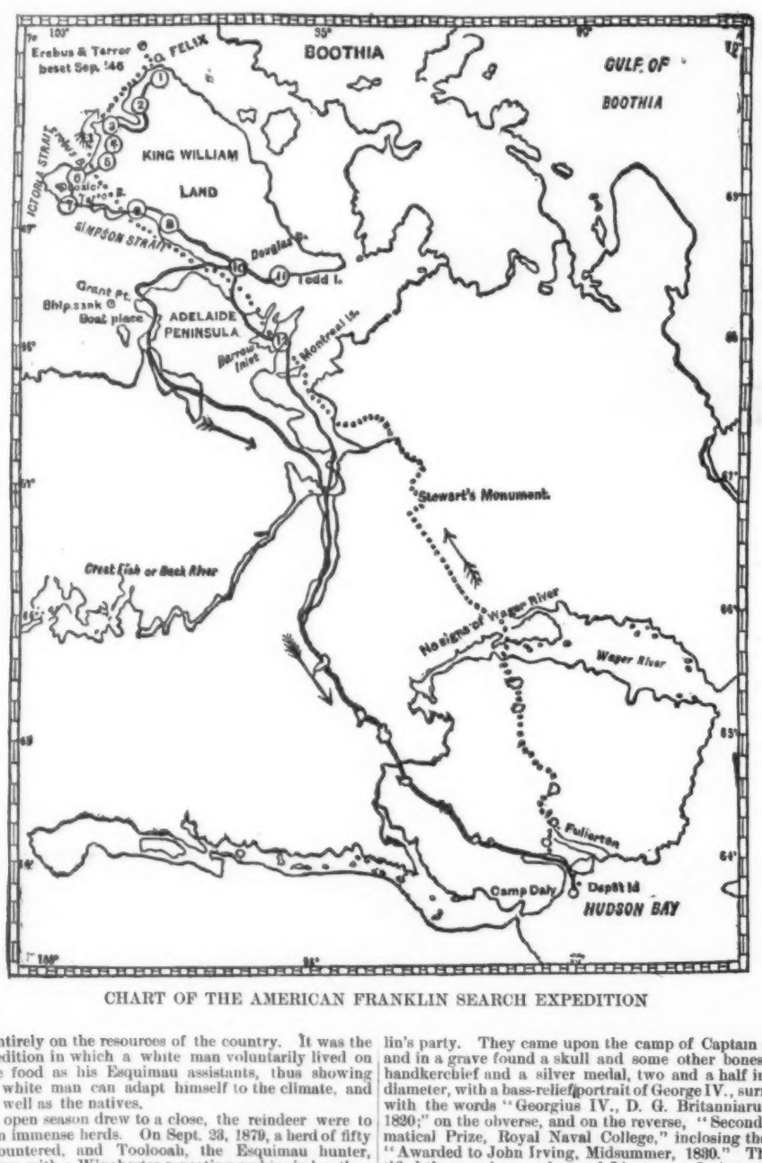


CHART OF THE AMERICAN FRANKLIN SEARCH EXPEDITION

THE probable value of the electric light for illuminating river ways and docks so as to enable navigation to proceed after dark, has long been recognized; but the Germans appear to be the first to put it to the test of actual experiment. Thanks to the enterprising lead of Dr. Werner Siemens, a series of important trials have recently been made on the Rhine.

CAPTAIN CARVER'S EARLY TRAVELS IN AMERICA.

THREE YEARS' TRAVEL—1763–1776—THROUGH THE INTERIOR PARTS OF NORTH AMERICA FOR MORE THAN 5,000 MILES. BY CAPT. JONATHAN CARVER, GLASGOW, 1805.

THE Ottawa Indians eat a kind of bread made of corn when in the milk; they slice the kernels from the cob and knead them into paste. For this no water is needed, as the milk in corn is sufficient. They then parcel it into cakes which are inclosed in basswood leaves, place them in hot embers, when they are soon baked; the flavor is excellent.

Green Bay was called by the French the Bay of Puants or "Stinking Bay." Carver remarks that the French had a different name for lakes or rivers, etc., from that used by the Indians, for, if in the presence of the Indians they were named, or a place named which they knew, they would be very jealous, for not understanding the conversation, they would become suspicious. From this, persons have since become perplexed with two or more names for the same place or object.

Carver mentions that sumac grew in plenty, the leaf of which, gathered at Michaelmas, when it turns red, is much esteemed by the natives. They mix about an equal quantity of it with their tobacco, which causes it to smoke pleasantly. He also speaks of a kind of willow (probably dog-wood, or *Cornus sericea*) termed by the French *bois rouge*, in English, red wood. Its bark, of one year's growth, is a fine scarlet, becoming gray as it grows older. The bark, scraped from the sticks, dried and powdered, is also mixed by the Indians with their tobacco, and held by them in the highest estimation for their winter smoking. The Indians also used leaves of another plant called by them Legockimac, to mix with their tobacco.

Carver concludes that the Winnebagoes originally resided in New Mexico, and being driven out took refuge in more northern parts about 1660. His reasons for believing this are: First, their inalienable attachment to the Nandowessie Indians, who now (then) live six hundred miles distant. The Nandowessie Indians, I suppose to be a branch of Dakota or Sioux. Second, their dialect differs totally from every Indian nation yet discovered—being uncouth guttural jargon, which none of their neighbors will attempt to learn. They converse with other nations in the Chippewa language, which is the prevailing language from the Mohawks of Canada to those who inhabit the borders of the Mississippi. Third, their inveterate hatred of the Spaniard! and an elderly chief informed Carver that forty-six winters ago (forty-six years prior to 1763) he marched at the head of fifty warriors toward southwest for three moons; that during this expedition, in crossing a plain, they discovered a body of men on horseback who belonged to the black people—for so they called the Spaniards; further states that, fearing a defeat, they waited until night and rushed upon them and killed most of them, and they took eighty horses loaded with what they termed white stone; this was probably silver, and their horses were shod with it and bridles also ornamented with it. This affair probably took place on the head of Rio del Norte. The town of the Winnebagoes consisted of fifty houses, strongly built, with palisades, located on an island of nearly fifty acres. The Winnebagoes raised corn, beans, pumpkins, squashes, and watermelons, with some tobacco.

Carver next visited a town of the Sankies containing ninety houses, each large enough for several families. These were built of hewn planks, neatly jointed, and covered with bark so compactly as to keep out the most penetrating rain. Before the doors are sheds, where the people sit and smoke. The streets are regular and spacious. Their plantations are neatly laid out.

He next visited the Ottagammies, whom the French named Des Reynards or "the Foxes." About five miles from the junction of Wisconsin (spelled Ouisconsin) with the Mississippi, he observed remarkable ruins of a large town recently inhabited by the Indians. On the Mississippi, some miles below Lake Pepin, he perceived what seemed to have been an intrenchment or earth-work thrown up four feet high and nearly a mile in extent, and sufficiently capacious to cover five thousand men. In form, circular, its flanks reaching the river. Though much defaced by time, every angle was distinguishable and appeared regular and fashioned with great military skill.

Near the River St. Croix there resided at that time three bands of Nandowessie Indians, called the river bands, for they chiefly dwelt near the Mississippi, and were then composed of eleven bands. Originally there were twelve, but the Assinipoils had some years previous revolted. Three bands reside near the river; the other eight were called Nandowessies of the plains, and dwelt to the westward. The names of the three river bands were Nehogatawonahs, Mawtawbauntowahs, and the Shahsiveentowas.

About thirty miles below the Falls of St. Anthony he notes a remarkable cave containing a transparent lake. He observed many rude hieroglyphics cut upon the inside of the walls.

The River St. Pierre (St. Peters) falls into the Mississippi ten miles below the Falls of St. Anthony, and was called by the natives Waddapawmencsotor.

At the Falls of St. Anthony a young prince of the Winnebagoes made an offering and address to the Great Spirit, and he considered the falls to be one of his residences. He first made an address to the Great Spirit, then threw his pipe into the stream; then the roll that contained his tobacco; next the bracelets of his arms and wrists; then a necklace of beads and wires from his neck; then his ear rings, during all of which he frequently smote his breast with great violence, threw his arms about, and appeared much agitated. He invoked that the Great Spirit would constantly afford Carver a bright sun, a blue sky, and clear and untroubled waters.

Carver passed up St. Pierre's river two hundred miles to the country of the Nandowessies of the plains. Among some of these he resided seven months. They are termed the Wawpeentowahs, the Tintons, the Arahcootans, the Mawhaws, and the Schians. The other three are the Schianese, the Chongonsceton, and the Waddapawjestin, and they dwell higher up to the west of the River St. Pierre, on unbounded plains. The Nandowessies, united, consist of over two thousand warriors. Some of them drew plans of countries, with a piece of charcoal, upon the inside of the birch tree bark. He says, never did he travel in so cheerful and happy a company. Carver states that on a branch of St. Pierre's River, called Marble River, is a mountain from which the Indians get a sort of red stone, out of which they make the bowls of their pipes. A white clay also abounds, suitable for pottery, and a blue clay that the Indians use for paint. The latter they mix with the red stone and paint themselves of different colors.

The Chippeways, he speaks of as being the nastiest people he ever saw, and speaks of a custom, named by others, of

searching each other's heads and eating the prey there found.

Carver particularly describes the lakes and streams west of Lake Superior. Lake Winnepeg he spells Winnepeek, and the Missouri River he speaks of as the Messorie. He relates that it is said that in the country of the Pawnees and Mandrakes are found a species of root resembling human beings of both sexes! He also states that a little to the northwest of the head of the Messorie (Missouri) and St. Pierre (St. Peters) the Indians told him that there was a nation smaller and whiter than the neighboring tribes, who cultivated the ground.

He speaks of the Shining Mountains far West, probably the Rocky Mountains, and the natives there have plenty of gold. Further on he speaks prophetically of these mountains, of which time has proved much, and says: "These mountains are more than three thousand miles long. Probably in future ages they may be found to contain more riches in their bowels than those of Industan, Malabar, or are produced from the golden coast of Guinea, nor will I except even the Peruvian mines. West of these mountains future generations may find an asylum, whether driven from their country by the ravages of lawless tyrants, or by religious persecutions, or reluctantly leaving to remedy the inconveniences arising from a superabundant increase of inhabitants."

Carver mentions a remarkable phenomenon connected with the straits of Michillimackinack. "In seven and a half years they rise three feet, and the next seven and a half years they decrease three feet." He had no opportunity to prove it, but something was taking place.

The book contains additional information concerning the origin, customs, etc., of the Indians of the Northwest; also botanical and geological information, all interesting.—*G. C. B., in Kansas City Review.*

RECENT PROGRESS IN PHOTOGRAPHY.

"ANOTHER revolutionary power in photography," is the heading of an advertisement which appears in some of our weekly technical journals, and it is this revolutionary power to which we propose to refer, in the first place premising that the exclusive right of its exercise does not appertain to the individual who thus attracts the attention of that portion of the public who are interested in photography. As a matter of history, it may be as well to mention that several years ago Dr. Maddox obtained sensitive photographic plates by emulsifying bromide of silver in liquid gelatine, coating glass plates with the product, and then drying the film. He was subsequently followed by Mr. Burgess; but not till Mr. Kennett's process was published was anything practicable for the use of the general public made known. But, notwithstanding Mr. Kennett's fostering care, the gelatino-bromide process—as it was incorrectly called—did not make much way, since it appeared to possess but few advantages and several disadvantages when compared with the old collodion processes with the nitrate of silver bath, or the newer ones in which bromide of silver was suspended in collodion.

Some two years ago the whole photographic world was startled by the announcement that Mr. C. Bennett could obtain pictures in the camera in but a fraction of the time necessary with any process extant up to that time, and he demonstrated the fact to the satisfaction of every one. The process he used was founded on that of Dr. Maddox, and consisted of bromide of silver in a state of minute subdivision held in suspension in a viscous solution of gelatine. The rapidity was gained by keeping the gelatine containing the suspended matter in a liquid condition for several days, the molecular state of the sensitive compound being altered by the prolonged liquefaction. Some idea of the exquisite sensibility of bromide of silver can be gathered from the fact that M. Stas, the great Belgian chemist, while making his classical researches on the atomic weight of bromide, found one particular form of this compound which was speedily blackened by the feeblest yellow light—a light which, as a rule, is totally inoperative to cause the slightest change in bromide of silver. To revert, however, to Mr. Bennett's process. It was, indeed, a new power placed in the hands of photographers, and it need scarcely be said that portraitists were not long in adapting it to the requirements of the studio, or, perhaps, to speak more correctly, to adapt the studio to the requirements of the process. Many of our readers must remember the often painfully lengthy pose—perhaps a minute - required from them in the dull days of winter in order to produce a passable likeness. Such a sitting was by the new power reduced to one-sixth of the length. Eminent experimentalists on the science side at once grappled with the subject, and by their researches the time of preparation is reduced from days to hours, and increased rapidity is attained; indeed, to such a degree that in some cases a photograph can be taken in from one-thirtieth to one-sixtieth of the time of the old collodion wet process. To these newer plates then, it is no misnomer to couple the term revolutionary power, and there is no doubt that a revolution in some branches of photography has taken place. Photography has known, however, greater revolutions than this—revolutions, indeed, which involved a complete change in the manipulations. Thus calotype, or the waxed paper process, with its development by means of silver, superseded the daguerreotype, in which the image was developed by mercury vapor; and, again, calotype, in which the foundation was paper, was ousted from its position by Archer's collodion process, in which the paper picture gave way to transparent glass and a substratum of collodion. The daguerreotype, it will be recollected, was a picture which was impressed on a metallic silvered plate, and which admitted of no reproduction in the commercial sense of the word, though it was and is still a glorious work of art, so delicate and rich in detail that nothing can surpass it for beauty.

It was not then surprising that any process was hailed which enabled prints to be made from what is technically called a negative picture, and calotype fulfilled this condition. When Archer introduced the collodion process, however, its superiority in rapidity and in the beauty of the prints produced from its negatives, at once gave it a place which it held till two years ago. The latter have none of the grain of the paper, which in small pictures marred the fidelity of detail, and, though not so exquisitely delicate as the daguerreotype, yet it was a wonderful stride toward perfection. In fact, the collodion processes by the wet or dry methods rendered photography capable of holding the place among our national industries which it now holds. It has now a co-partner, but not a rival, in the gelatine emulsion process.

In the recent photographic exhibition in Pall Mall we saw examples of the rapidity of which the gelatine process is capable. A train going 60 miles an hour was fairly expressed on the photographic plate, there being a sharpness of image which was truly marvelous. The 1-150th part of a second is a short interval of time, yet in such a time the picture was taken. Again, one of the pictorial series of interest of the year was a series of views on the river Thames by Mr. Mayland. The silent highway is sparkling with motion, shipping and steamers at full speed being rendered sharply and clearly—in fact, the idea of motion is conveyed by the foaming tracks and curling waves which they make in their passage.

Drawing-room photography by amateurs now becomes a possibility and a practicability which before it was not, and in one remarkable picture of the year we have a dark interior of a room, and the portrait of a charming model secured on one plate in 25 seconds of time. In the old days such a combination would have been impossible, except by printing from two or more negatives. Mr. H. P. Robinson, whose artistic work is so well known and so greatly admired, has thus scored a success in adapting the process to his peculiar style of pictures. In science, however, the rapid plates have proved of more than yeoman service.

One of the most marvelous feats, however, of photography is the portrayal of the motion of trotting, cantering, and galloping horses by Mr. Muybridge, in America, in which he shows changes in the position of every limb during minute fractions of a second, and this settles certain points which have long exercised the minds of certain eminent physiologists.

If we quit the more rapid process and come once more back to the old collodion process, we find that it has also done good service in scientific research. In the Bakerian Lecture of the Royal Society for the past year, Captain Abney has shown how the sensitive compound bromide of silver can be so modified as to cause radiations of very low wave-length to impress themselves on the photographic plate, and in a map he gives the Fraunhofer lines which exist in the solar spectrum far down below the visible red rays of the spectrum. In the prints as usually supplied, the images, which are built up of minute particles of silver, gradually fade and become worthless.

The simplification of the Woodburytype process, and of printing in printing ink from gelatine surfaces, is still making progress, as evinced by the number of specimens of each which we see in books of travels, or of transactions of antiquarian and learned societies.—*London Times.*

ENLARGING BY THE GELATINE PROCESS.

By H. J. PALMER.*

AT this time of the year the photographic opportunities of most of us—as amateurs—are of necessity very limited in their character; but the production of enlarged copies of smaller negatives taken during the past season is an employment for a winter's evening full of interest and conducive to results of a very pleasant kind.

The gelatine process enables us to practice the art of enlarging without the expenditure of an undue amount of time or of means. For, with a sciopticon—or, indeed, with any of the numerous modern lanterns provided with a duplex or triplex paraffine lamp—an enlargement on a gelatine plate of the largest size, and composed of a slow-but-sure emulsion, may be made in from five to ten minutes. And then, with regard to cost, a plate 20 by 15 may be sensitized with a gelatine emulsion for an expenditure of three pence or thereabouts; and the mode of procedure is simplicity itself.

I will give a brief account of the preparation of a plate. I used an emulsion consisting of 20 grains of gelatine, 12 grains of silver, and 8 grains of bromide of ammonia to the ounce. This was prepared in the evening, in a concentrated form, *i. e.*, with half the necessary amount of water, and placed on the bottom or warmest shelf of the drying cupboard, in close proximity to the opening at the apex of an iron cone, with a small gas burner below. Having been left all night to cook, in the evening it was poured out into a porcelain dish, placed under a dripping tap of cold water till business hours were over in the evening, and then, after draining and warming, it was poured through glass wool into the porcelain cup of a child's food warmer, and the whole brought up to its full quantity by addition of alcohol and water in equal proportions.

A plate was now made comfortably hot at the fire, and placed on the open palm of the left hand. Three ounces of emulsion, which had been measured out in a warm measuring glass, were poured on to the center of the plate in a pool of circular shape, and even distribution over the surface was effected by means of the fingers of the right hand. No glass rod or contrivance of any kind that I have met with can compare with the fingers and hand as distributers of emulsion over the surface of a large plate; but I do not recommend their employment for this purpose if they have been recently in contact with the hyposulphite, or, indeed, with anything save soap, water, and towel. A large surface of gelatine sets very speedily, and therefore as little delay as possible was employed before the plate was deposited on the leveled shelf. I have noticed that there is a considerable difference between the rapidity of setting of gelatine of various makes. Nelson's photographic gelatine sets more quickly than the opaque, and the French Coignet is the slowest of all. I recommend this last, then, as the preferable kind for sensitizing plates of large size.

The crux of the gelatine process for amateur makers of plates lies in the drying. A small plate can easily receive an alcohol bath, and so be speedily ready for exposure; but that is not so practicable with a film of large dimensions. The difficulty in the way of the use of alcohol lies in the fact that it removes all varnish from the wooden trays in which it is applied to plates of large size, and porcelain trays are not usually to be found of sufficient capacity in our laboratories.

The great secret of success in coating plates of considerable size rests with the amount of emulsion poured, in the first instance, upon the surface to be covered. If this quantity be insufficient, it will be impossible to flow the gelatine over the whole of the plate, and the result will be misery and mess. I mentioned three ounces just now as the quantity necessary for a 15 by 20 plate; but it will be found far better to have courage to pour much more than this upon the warm surface first, and, after flowing it nicely around the edges and corners in succession, to return the surplus to the vessel. This, I think, is the secret of successful coating of plates of all sizes—to have the courage to pour a plentiful pool of emulsion at the first. I recommend the palm of the hand as the best plate holder; for I have never yet met with an artificial contrivance which could be depended upon to keep a firm grasp upon its plate until coating was completed.

There is no need of apparatus of any kind beyond an ordinary lantern, and a transparency for the production of a gelatine enlargement. I usually employ a plate box accurately placed in a parallel position to the plane of the lens of the lantern, and against this I rest a sheet of cardboard for focusing, and the sensitive plate afterward. The time of exposure depends, in the first place, upon the sensitiveness of the emulsion employed; and, in the second place, upon the size of the enlargement. It is not likely ever to exceed ten minutes, though it may be modified also by the density or thinness of the transparency employed. It should be borne in mind, in connection with this subject of enlarging by the gelatine process, that small negatives which are worthless for printing, from over exposure, are often capable of producing very fine positives with the lantern. And nothing can exceed the beauty of an enlarged positive on an opal plate when rightly exposed and developed with ferrous oxalate.

* Abstract of a paper read before the Liverpool Amateur Association.

ON THE PREPARATION OF GELATINE EMULSION.*

AT the suggestion of the Hon. Secretary of the Manchester Photographic Society to explain the working of my injector for emulsions, which I did at the October meeting, and having made some observations relative to the preparation of emulsions, I have been asked to put together, if possible, the remarks I made at that time. I now make the attempt, and I hope what I may say will help a little. The injector exhibited was a ten-ounce one, consisting of a small bottle, an intermediate stopper, and a larger bottle. I will now give my process of making emulsion, using the parts of the injector to illustrate my mode of working.

Into the smaller bottle I put 150 grains of nitrate of silver dissolved in six drachms of water. I then add by degrees liquid ammonia (880) until the oxide of silver formed is redissolved and the solution bright. In the larger bottle I place 30 grains of gelatine, 100 grains bromide of ammonium, and 5 ounces of water. After standing for a short time I apply heat to dissolve, heating the stopper bottles and their contents to a moderate temperature. The concave end of the stopper must now be placed upon the smaller bottle, then inverted into the larger bottle. The combined bottles are now grasped by the right hand, with the thumb pressed firmly upon the upper bottle, and in that position is agitated by percussion either upon the palm of the other hand or otherwise on a pad formed out of a handkerchief rolled up, ball shaped, until the silver solution is injected. A little more water may now be added to rinse out the remaining silver; then inject as before. It is important that the rubber rings are kept round the stopper to prevent jamming of stopper and bottles.

Place the emulsion in a cool place to set; when in that condition break up the mass into small particles by means of a thin glass rod, filling the bottle with water at the same time. When it has settled pour the excess of water off; repeat the operation three or four times, and finally tie a piece of fine muslin over the neck. Then invert the bottle to drain upon a thick pad of blotting-paper (which latter, after drying, may be used over and over again).

The emulsion must now be heated up to boiling point to remove the excess of ammonia; the olfactory nerve must determine that. Water is now added to make the quantity up to 10 ounces, and then add the remainder of the gelatine, 170 grains. After standing for a time the emulsion must be heated until the gelatine is perfectly dissolved. The emulsion may now be filtered through wash leather or a funnel plugged with wool; it is then ready for use.

Why I use so small a quantity of gelatine is that I consider the sensitive germ of emulsion is as fully secured in the small quantity as in using the full quantity; and, also, if the perfect removal of the soluble salt from the emulsified gelatine assists in conferring greater sensitiveness; you are more likely to secure that end by dealing with as little gelatine as possible in the first instance. There is no doubt the sensitiveness of a gelatine film depends upon the formation of a species of gelatinate of silver, so to speak, just in the same way that Fothergill plates are prepared. By pouring albumen upon a partially washed collodion plate you get superior sensitiveness, which is considered to be due to the formation of albuminate of silver.

My arrangement for warming the emulsion is by the usual decapitated, bottomless hock bottle with benzoline lamp, which I make serve two purposes—a light to work by, and the waste heat I utilize by placing at the top a hemispherical dish of copper, which I find most convenient for warming the emulsion dish and contents.

The next matter is measuring the emulsion for each size of plate. The spoon or ladle system of measuring I consider defective. As the emulsion requires to be stirred occasionally, it is impossible to do so without bringing about the "bubble" reputation, which is not very desirable, nor can it be avoided altogether; moreover they cannot well be seen owing to the opalescence of the emulsion. I find the use of a graduated glass syringe about the best for the purpose. There are two kinds of syringe known to the trade as "male" and "female." The latter is the preferable one. It has a rounded end with a number of perforations in it; is a most useful appliance; it may be used as a stirrer; takes up the requisite quantity for each plate without any bubbles whatever, if taken from the lower stratum of emulsion; it is also a useful distributer, and quite as effective as a glass rod.

ROBERT KNOTT.

* A communication to the Manchester Photographic Society.

GELATINE BROMIDE TISSUE.

WE have read several accounts of trials to make flexible gelatine pellicles in the style of Warnerke's emulsion films. It would be indeed very important to have such a tissue, which would make the practice of photography much less burdensome to travelers. We have obtained good results with Warnerke's collodio-emulsion films, but, for some reason, this ingenious product has not come into general use. Although the preparation of the collodio-bromide tissue is probably a difficult matter, it is our opinion that the preparation of gelatine bromide paper should be much easier. Everybody knows how carbon paper is prepared, a sheet of paper being drawn over the surface of a warm gelatine solution containing pigment; exactly in the same manner a band of paper could be coated with a gelatine solution containing bromide of silver. Warnerke gave his paper preliminary coatings of India-rubber and plain collodion, and perhaps a similar preparation would be necessary for the gelatine bromide tissue. Warnerke removes the film from the paper after development, and mounts it on glass; but it might be more convenient to let it dry on the paper, and then to render it transparent by means of wax or a suitable varnish. Perhaps such tissue would become of very high importance for making positive prints on a large scale by means of artificial light. We mention here that on one occasion we

wished to reproduce fifty copies of an astronomical photograph, and, as no daylight was available, performed the printing operations by gaslight—commercial gelatine plates being employed—the exposure, at seven inches distance, about eight seconds, being eight seconds at a distance of seven inches from the flame. In this way we produced fifty pictures in about one hour, and no doubt it could be done in a much shorter time, provided that convenient arrangements were at hand. But although we say one hour, we must confess that fixing was not included. Why is the time required for fixing gelatine plates of commerce so widely different? We have obtained plates which were fixed in five to six minutes, and other plates from the same manufactory needed at least half an hour for perfect fixation. Such plates could be fixed much more rapidly by means of cyanide, but sometimes we lost a plate because the alkaline fixing solution dissolved the gelatinous film.—*Photo. News.*

GOUPIL'S PHOTOGRAVURE.

THE process of photogravure worked out after the Woodbury idea in Goupil's celebrated establishment with admirable success, has induced many to offer suggestions as to the best manner of obtaining a grain gelatine relief. Certainly Major Waterhouse's researches, as described in the Photographic Society's Journal, are very valuable, but it is doubtful whether his method is identical with M. Rousselon's. All artists acknowledged M. Goupil's photogravure as the most artistic photo-mechanical process of the day, and, we must add, it is a cheap one. We have purchased a photogravure, after a landscape painting of Lier (size of the picture 24 by 18 inches), for £1, while we have paid more than double the sum for a silver print of the same size. Would it not be possible to obtain the same results, especially with the co-operation of Mr. Woodbury, the original inventor? Indeed, Goupil has spent many thousand pounds in working out the process, and in making it really practical, while perhaps any other person who would wish to do the same would have to expend a like amount. But it seems clear that the result can be obtained by others, as we have before us some pictures of Makart, the celebrated Austrian painter, reproduced by a photo-mechanical process of Mr. Klic, engraved in Vienna. The reproductions are so similar to Goupil's photogravures that they might be confounded with each other. We know that M. Goupil employs the electrolytic method for reproducing his photo-reliefs in copper, and he requires about four weeks for the deposition of the necessary thickness; but Klic, we are informed, only wants three days for making a copper plate from a negative.—*Photo. News.*

PREPARING GELATINE PLATES IN THE STUDIO.

WE have recently had an opportunity of conversing with M. Mottu, of Amsterdam, who is one of the best known continental makers of gelatino-bromide plates, and this gentleman expressed the opinion that, after two or three years, every photographer will prepare his own gelatine plates. We cannot agree with this opinion, as all know how very easy it is to make albumen paper—easier, certainly, than to prepare gelatine plates. Yet only a few photographers, and the owners of very large establishments, make their own albumen paper. How few photographers possess really suitable rooms for the preparation of dry plates? How few can find time for watching over the process, and for making the emulsion? The process may be easily worked out in the winter time, but in hot summer months the whole aspect of affair changes, and a period of trouble sets in, enough to drive the already over-worked photographer out of his senses. We are informed that last summer almost all of our gelatine plate makers were compelled to work during the night, because the temperature during the day time was so high as to cause constant difficulties to arise. The troubles incident to developing and fixing gelatine plates in hot weather are sufficient to exhaust the patience of the average mortal, but in working with Dr. Vogel's emulsion we are informed that these troubles are eliminated. Until, however, more is known of this preparation, we must withhold our final judgment. Why is it not yet introduced into England? In France it is manufactured by M. Schaffner, of Paris. Our excellent confrère and correspondent refers to the matter in his interesting Paris letter of December 10: "We are surprised to find no one has given an authoritative opinion on the new product." We beg to call attention to the fact that a first rate man like Dr. Eder has given a very favorable report on the subject in the July issue of the *Photographische Correspondenz.* We hope soon to hear more on the matter.—*Photo. News.*

BROMINE IN THE FATTY ACID SERIES.

By CARL HELL and FR. URECH.

THE authors give tables showing the progress of the reaction of bromine with the acetic and propionic acids, normal butyric and isobutyric acids, the valerianic, capronic, and caprylic acids. They recognize three successive stages: that of slow action, from the beginning of the application of heat till ten to twenty per cent. of the molecules of bromine present have entered into reaction, the stage of acceleration, which lasts until about sixty per cent. of the bromine has acted, and the final stage of retardation, which lasts till the process is complete. The effect of the molecular magnitude appears in the first stage. In acetic acid fifteen per cent. of the bromine molecules present are substituted in forty hours; in the next homologous acid this proportion is reached in ten hours, in normal butyric acid in 7, and in isobutyric acid in two.

THE MINERAL CONSTITUENTS OF YEAST.

WHEN yeast is burned a very appreciable residue remains, which amounts to from five to eight per cent. on the weight of the air-dried yeast. This residue or ash consists of mineral constituents, among which the phosphates of potash, lime, and magnesia are the most conspicuous. In the cultivation of yeast, therefore, these salts become a necessity; wort made from good malt contains sufficient, but when glucose or cane sugar enters into the composition of the wort, there is usually a deficiency of phosphates; in such a case, the so-called "yeast-foods" are advantageous, as they supply the mineral constituents which are deficient in the wort. Occasionally brewers and distillers burn some of their waste yeast, and add the ashes to the fermenting wort, and such a proceeding has been found to produce very satisfactory results.

THE ACTION OF LIGHT.

OUR Huddersfield correspondent sends us the following account of a lecture on the Action of Light, delivered before the Dyers' Scientific Society of that town, by their president, Mr. D. Dawson, of Milnsbridge. The lecturer said:

I think it may be of interest to make a few remarks on the action of light on bodies. If the subject were reversed and stated in this manner—the action of bodies upon light—we should be landed upon a subject so full of intricacies and difficulties, that I should be totally unable to explain to you the many phenomena which it would involve. I only just need to mention some of these phenomena to make plain what I mean, viz., transmission of light through transparent substances, reflection from bright surfaces, refraction, decomposition, and polarization of light, which all belong to the province of optics. Now, the action of light upon bodies has quite another meaning. By it we mean its power to aid in the building up or decomposition of matter; in short, its power to act chemically. In the vegetable kingdom we see being built up vegetable forms on a stupendous scale, and this process of construction is in some occult way dependent on solar light and heat, the relative importance of which is not very clear. It is, however, well established that vegetation cannot flourish without light.

Now, what is the general chemical effect in all these natural constructive operations in which light plays an important part? Chemistry demonstrates that it is one of fixation of carbon, hydrogen, and nitrogen chiefly. Compounds of those are taken as the crude building materials, and are broken up in the constructive process, and the elements fixed in the edifice, so to speak, in the form of other compounds of very complex characters. Indeed, so complex are the natural organic compounds, that only in comparatively rare instances has the chemist been able synthetically to construct them, notwithstanding the vast feats of synthesis which have been performed since a more accurate insight into the constitution of bodies has been gained. These crude building materials of nature, viz., carbonic acid, water, and ammonia, require for their breaking up a most stupendous chemical force ere their carbon, hydrogen, and nitrogen are fixed in the plant in the form of other combinations.

To illustrate the force required for this work, which is apparent at once to one acquainted with thermal chemistry, let us take, for example, the most abundant material required in building up all organisms, viz., carbonic acid, and try to form some idea of the force which binds together the two elements in this compound. If we take a great many of the metallic oxides, and submit them to the most violent treatment out of contact with other reagents, such is the tenacity with which the oxygen and metal are held together, that they undergo no change whatever; but if heated in presence of carbonic oxide, then they are robbed of their oxygen easily, the carbon having a still stronger affinity for oxygen than the metals themselves. Most of the metallurgical operations in which metals are extracted from their ores are based upon this strong affinity of carbon for oxygen; and yet strong as this is, it is split up easily under the threefold influence of vitality and light and heat.

During the process of growth of a plant the carbon is fixed in its structure, and part of the oxygen is sent back into the atmosphere. Now, it is strictly according to law that the force absorbed in bringing about chemical changes, whether direct or indirect, the same force will be given off in the contrary process of restoring the matter to its original form. Therefore when we burn organic matter, let us say wood, coal, etc., the heat given off represents exactly that absorbed during its growth, for the matter in combustion is returned to the same state in which it existed when the plant seized it as nourishment. This fact again furnishes an excellent idea of the forces which operate in these natural phenomena.

It has somewhere been stated by a writer that to-day we are running our steam engines with solar light and heat which has been bottled up for us in the earth for millions of years. This is absolutely true. After these few remarks on the action of light in the natural world, which goes on quite independently of man's inventions and operations, and indeed, went on long before man existed, let us consider what little use, as yet, man has made of this subtle yet powerful agent.

The most conspicuous application of light to the purpose of art is in photography. Nothing in the whole range of applications of the natural forces to the purposes of art can excel the results obtained by photography for exquisite accuracy. Let us illustrate this by taking a photograph; and at the same time I will endeavor to explain briefly the process. Here is a solution of gun cotton in ether. This solution is called by photographers collodion. I take one of these plates and pour this solution over it in such a manner that it flows as quickly as possible over the whole surface of the plate, and the excess is allowed to drip off at one corner back into the bottle, during which the plate must be tilted to and fro, so as to avoid the formation of streaks. The production of a uniform film on the plate is a point of great importance. As ether is a substance extremely volatile, it quickly evaporates and leaves the gun cotton as a tough film adhering firmly to the plate. Now, besides gun cotton there is also a small quantity of iodide of potassium dissolved in the collodion, so that this substance will also be left on evaporation of the ether thoroughly incorporated with the film. This being done, the plate is next immersed in a bath of nitrate of silver. The merest tyro in chemistry will now be able to explain what will take place between the iodide of potassium and nitrate of silver. The elements simply transpose themselves so as to form iodide of silver, which remains on the plate, and nitrate of potassium, which washes into the bath. While this plate steeps a few moments in the bath, so as to insure a complete reaction between the substances, we will just focus an object in the camera.

You see here an inverted image of the object on the ground glass. Now I will bring the prepared plate in a dark slide, which is designed to protect it from exposure to light during its passage to and from the camera. I place the slide in the camera, and the plate which it contains is now in the exact place where the image was seen on the ground glass. I now draw out the door, and allow light to fall upon it. A few seconds is sufficient in good light, and the action has now taken place. The parts which have been exposed to light from the object have been affected, while those kept dark remain unaffected. The exposed and unexposed parts have now different chemical properties, as is proved by the treatment which I am about to submit the plate to, which consists in the first place in pouring on it in the dark room a solution of sulphate of iron, when we see in those parts which have been exposed to light a rapid reduction of the silver compound to the metallic state. After washing away the excess of sulphate of iron, a solution of cyanide of potassium is then poured over the plate, leaving the silver as the paint, so to speak, of the picture. Here is the picture. Although not perfect in a photographic point of view, it has, nevertheless, illustrated my point; that is to say, the action of light on bodies. But, as might be supposed, the action of light is not by any means restricted to silver compounds. Indeed, in the photographic art itself, which at one time knew only of silver compounds as light alterable substances, there has been in recent times other substances introduced in substitution of silver compounds. For instance, in the carbon printing process, whereby enlargements to very large sizes can be obtained, chromic acid is the light alterable substance employed.

Now, as dyers, in whose hands this substance, as bichromate of potassium, is so largely and often found, I deem it well worth your while to pay attention to this peculiar property of chromic acid, as in some cases it may have some bearing upon your art. I will just mention one fact just to show you why I think so. At one time I made many attempts to fix aniline black on cloth, and I succeeded to that extent that I think it might be usefully adopted in cases where the shade would be suitable. My first process was to work the cloth in a somewhat strong bichrome black, acidulated with sulphuric acid. One bright summer's day, some of the cloth which had been chromed as indicated was thrown up out of doors. After a time I found the light had acted upon it powerfully, the exposed parts having darkened considerably.

Now here was an observation which was destined to prove the nature of the change which the chromic had undergone, for my next operation proved that there had been a reduction of the chromic acid, because those parts which the sun's rays had acted upon did not develop the aniline black to the same extent. It is obvious the chromic acid had yielded some of its oxygen.

The photographer and the dyer stand, in respect to the influence of light on their respective arts, in quite dissimilar positions. The photographer makes use of light as a constructive agent; it is his main agent to obtain the results desired. Now the dyer has to consider the action of light in quite a different aspect. Instead of serving him as it does the photographer—as an aid to obtain the results aimed at—he regards light as the great destroyer of his work. Indeed, light in one sense, while being the friend and ally of the photographer, is the great enemy to the colors fixed by the dyer. No less on this account should the dyer make himself acquainted with its power of attacking his work; for it is one of the chief duties of a general to study the forces which can militate against him, in order that he may bring a superior force to successfully combat the enemy. The dyer, then, has to form a proper estimate of the attacking force of light upon his colors. This can only be done by actual experiment, by exposing them under proper conditions. Throughout the whole range of coloring matters used by the dyer we find a very wide series of gradations in respect to resistance of the decomposing action of light; some colors being attacked in a few hours, while others can withstand its action as many years. This is known not only to dyers, but generally, hence we have the common expression —"Don't have that color, because it fades." But since the introduction of such a great variety of new coloring matters into the art, the public will be puzzled in forming a judgment as to the fugitiveness or permanency of certain shades, and they will often be quite wrong in their conclusions; for the same shade will many times vary in regard to fastness, because it is often produced by the use of totally different coloring matters, each having its own specific power to resist the action of light. But the dyer should be so well acquainted with all colors in respect to light resistance, that he may select the most suitable for special purposes. Where it is of the utmost importance that a permanent color should be used, then of course he must have recourse to one of that class, although in other respects it might be disadvantageous. For instance, it might lack the desired brilliancy, facility of fixing itself to the fiber, or be somewhat detrimental to the material.

Although the resource of coloring matters is now so rich, chiefly by the addition of new coloring matters obtained by comparatively recent researches, the dyer is yet compelled in a host of cases to use fugitive colors where more permanent ones would be far better, because the circumstances in the dyeing operations and the properties of the colors are such that there is sometimes but little choice left as to which must be used. Those circumstances have to be met, even if the color selected be somewhat fugitive. For instance: how many colors are all that could be desired as regards woolen dyeing? But when it is a question of bringing cotton up to the same shade in the same fabric, the dyer has to hunt for another color to accomplish the end, and he often fails to find one in which are combined all the properties required for the purpose. Well, then, he has only to do his best, and the public will have to be satisfied with the best attainable.

The requirements of fashion are so great that it is no wonder the dyer still lacks the means of completely meeting them satisfactorily. But perhaps on this very account the art is more interesting, as it furnishes a field for constant experiment with a view to remove ever-recurring difficulties; and, with the aid of the chemist, the dyer has from time to time removed many obstacles which seemed almost insurmountable. Let us hope, then, by perseverance and application he will always be able to cope with them. The technical schools which are springing up around us, combined with more extended scientific knowledge, will give him immense assistance in his attempts to find new applications for coloring matters, or improved methods of using them.

I have now an observation to lay before you which further illustrates the action of light. I have mentioned the alteration of chromic acid in cloth by the influence of the sun's rays. I think I established the fact that the alteration was due to the reduction of chromic acid. Now it occurred to me that if chromic acid is rendered more deoxidizable under the influence of strong sunlight, or, what is the same thing, becomes a more powerful oxidizer, it might be made to act upon matters which are capable by oxidation of developing a coloring matter, at an accelerated rate, with the assistance of solar light. That the rate of action is so accelerated I will show you a plain proof. It is evident that this accelerated action furnishes the elements for taking a photograph. Here are several formed by the fixation of aniline black on paper by the aid of sunlight. I have now only to show you three colors which I have exposed about fourteen days. I have exposed them in a novel manner. I have placed them under a photographic negative. I have selected two of the most fugitive colors, viz., magenta and crysoidine; the other is an azo compound, and far more permanent. You observe the magenta and crysoidine have

given photographs, although very indistinct, while the azo compound has not yielded to the action of the light.—*Chemical Review.*

OSTRICH FEATHER DYEING.

By PAUL ALEX, Practical Feather Dyer.

IT is possible that some of the readers of this journal think that I should write full recipes to accompany all the colors I mention. It would, no doubt, be much more interesting and perhaps profitable to them. But I do not think it would be advisable, and for the following good reasons: First, because there are no two dyers that make colors in the same way. There are not, perhaps, one in ten that would strictly follow the directions; consequently, the result would not be satisfactory, and the recipe (however good) would forthwith be contemptuously condemned. Second, there are no two dyers who use exactly the same brand of colors. For instance, take logwood; how difficult I find it to get two barrels of exactly the same strength. For fully six years all the colors used by me I obtained at one house, and when I began to buy from others I experienced very considerable trouble in getting satisfactory results—not because the colors were unequal in goodness to those I had been using, but because I did not understand and was not familiar with the strength and quality of them. The majority of dealers in colors know no more about the manipulation of ostrich feathers than a child. I am in almost daily receipt of samples of dyestuffs that are invariably guaranteed to produce the most beautiful shades of blues, greens, reds, etc. But I find that I can use but very few of them.

I promised a few months ago to give the readers of this journal the names of all the dyestuffs used by me, and in accordance with that promise I herewith present a full and complete list. With these I claim to be able to make any color that art or nature ever produced. They will be found to be about thirty in number, viz: Logwood, turmeric, fustic, sumac, copperas, bluestone, verdigris, bichromate of potash, extract of orchil, salt tartar, aniline brown, green crystals, cochineal, marine blue (bluish), marine blue (reddish), extract of safflower, solferino, magenta, bengaline blue, bengaline black (this last-named color can, I believe, be found but in one house in the country), picric acid, Nicholson blue, indigo blue, and reddish essence of coffee, which last will, with the aid of acid, produce the most beautiful shades of cream color. Of the thousands of shades there exists not one that cannot be made by the above list of colors.

With the six following colors, viz., turmeric, logwood, bichromate, aniline green, marine blue, and orchil, I can produce over two hundred distinct shades. I would here remark that any good artist ought to be able to produce as good colors by gaslight as by daylight.—*Textile Colorist.*

FEATHER DYEING.

Intense Blue.

THIS color is a pale blue—it is sometimes, but improperly, called "Gens d'Arm." It is obtained with comparative facility upon soft, hard, or ostrich feather, by an application of indigo-carmine and archil. It is more difficult to produce it upon skins, wings, and birds. Of course, much indigo-carmine and little archil should be used. Often, in order to make blacker, some black varnish is added to either the acidulated bath, or to a separate or unacidulated one. This process, however, is not to be recommended; it is better to add a little more archil, and, at the same time, very little curcuma. Orange Z may also be taken.

Marine Blue.

This is a dull color, more or less violet-tinted. It is obtained from indigo-carmine and lilac (violet is often substituted for this last color). To produce a deeper tint add a trifle more of archil. Even for very pale marine blue, nothing but indigo-carmine and archil are sometimes taken. For a flat feather the violet is employed to advantage. As regards the ostrich, on the contrary, lilac is preferable, for the violet is easier produced, giving a more uneven color than the lilac.

The bath should be acidulated with archil, not with sulphuric acid, that being too powerful. When the feather is in the boiling bath, indigo-carmine is first poured in, and next a mixture of indigo-carmine and lilac. To deepen the dye archil is added (but in exceedingly small quantities), as it produces considerable efficacy. Time must be given, however, to produce this effect, for it is known that archil bites slowly, and at a comparatively low rate of temperature. If too much archil be taken, it will suffice to give the feather another boiling hot bath with indigo-carmine and violet.

The white ostrich feather of good quality easily takes a marine blue color with indigo-carmine and lilac; but that which has been used a little, and above all the gray, becomes brown, or rusty, almost inevitably, as will be seen when we shall have occasion to speak hereafter of metallic reflects.

The difference in the nature of feathers belonging to one and the same lot is the cause of a very great inequality—some feathers being more reddish or greenish than others—so that after an energetic heating it is well, in drying the feathers, to range them in order of tint, and treat each species separately, boiling the hardest, or those feathers not reddish enough, longest in the original bath, and giving, on the other hand, a boiling hot bath of indigo-carmine to those which are too reddish. This operation being evidently too long, is unfortunately inapplicable to cheap feathers.

For skins, wings, and birds, the same processes are employed. Much precaution must be had that not too much sorrel salt be used, and above all, that the process be effected as quickly as possible.

Plum.

The plum color is a pale violet. The feather is dyed in a bath acidulated with sulphuric acid, archil, indigo-carmine, and black gloss, so that an almost black garnet may be produced. It is well to add a little lilac. The feather is taken out of the bath only at this moment. It is rinsed in pure water and then given a violet tint in a more or less heated solution of carbonate of soda. During this operation the archil turns from red to violet. Black is developed and settles more firmly on the feather, while a large portion of the indigo-carmine goes off. It is a primitive process, and certainly not economical, but which, nevertheless, gives good results in skilled hands, but in the hands of unskilled operators it is extremely tiresome and of doubtful success.

Second Process.

This is a direct process. Plum, which is but an impure pale violet employed in a bath acidulated with acetic acid, is taken for it. The dye is deepened with grayish-blue or grayish-rose, according to the tint required. When a blue shade is desired, lilac is added to it; if on the contrary, then red eosine is added. This process, which is fairly successful in light plum, is more difficult of application in dark plum. When, then, a well-nourished plum is required, recourse must be had to the first described mode.

Gray.

There are a great variety of grays, resulting invariably from the mixing of any given color with black and white. It would be well-nigh impossible to describe them all; and as it would also be unprofitable, I shall limit myself to the principal kinds.

Pearl gray is a mixture of violet-tinted blue, with very little black and much white. It is obtained by the same process that serves to make white—that is to say, by a mixture of indigo-carmine and violet. I shall not now return to a description of this procedure, and shall only state that in the personation of pearl gray the quantities of the coloring matters employed are somewhat augmented.

Giselle gray is a mixture of white with black. It is easily obtained by dyeing the feather with a small quantity of gloss black. As there is always a residue of yellowish hue it becomes necessary to give it a rose color with cochineal. This operation is effected in a cold bath, acidulated with a small quantity of salt of sorrel. If it be an ostrich feather, starch is dissolved in it.

Silver gray is a mixture of white and blue tarnished with black in very small proportion.

Silver gray is obtained by employing roseate gray and blue gray in convenient proportions. These coloring matters are employed much diluted in a clear solution, and an acidulated bath is prepared with acetic acid or sorrel salt. The bath should be cold and, for an ostrich feather, contain starch; it should be simply cold or tepid if a tender feather is to be dyed, and a boiling heat in the case of hard feather.

Felt gray is a yellowish gray. It may be obtained in different ways; the following two being the principal ones:

First Process.

In a bath acidulated with sorrel salt or sulphuric acid the feather is first steeped; gradually a solution augmented with an extract of chestnut-bark is poured into same, alternating with a second solution of violet. According to whether the sample has a more greenish or roseate tint, archil juice or water rendered blue with indigo-carmine is added.

Sometimes, in order to produce a deeper dye, gloss black is also added; this is, however, attended with the inconvenience of producing a color that will rapidly change as soon as brought into contact with the air. In such a case it will be better to employ, jointly with the extract and the violet, rose-colored gray.

The procedure which we have just described is very old, particularly if gloss black is taken. It is, however, attended with some serious disadvantages.

First.—Difficulty of application, for one requires to be very clever to dye rapidly and well in this manner.

Second.—The extract of chestnut bark never gives a perfect equality, and when taken in too large quantities prevents the feathers from being restored in the drying process.

Second Process

Is more recent than the preceding one, and every way preferable. It consists in employing felt gray in connection with rose-colored gray. These two substances, of easy application, will serve for the generality of the tints in question. If it were required to produce a somewhat roseate hue, cochineal or violet might be taken; if, on the contrary, a green one, a very small quantity of indigo-carmine would be required. These coloring substances are applied, according to the feather and the tone of the color, in a cold, lukewarm, or boiling hot bath, acidulated with acetic acid or salt of sorrel.

Iron Gray, Steel Gray, etc.

These kinds of grays are usually rather darkish; the tints result from a mixture of blue, a good deal of black, and some white. They are obtained on the feather by means of a conveniently proportioned mixture of roseate gray and blue gray, the shade being subsequently imparted, as in the case of the other gray species.—*Textile Colorist.*

COSMOS FIBER OR VEGETABLE WOOL.

NOT the smallest of the many triumphs which the science of chemistry has achieved of late, has been added by a new invention, the universal adaptation of which to the textile industries will, no doubt, cause an entire revolution in their various branches. Mr. Anton E. Neumann, a Hungarian manufacturer, has, after many years of research and experimenting, succeeded in discovering a chemical process by which the fundamental difference between vegetable and animal fiber is actually removed. It is well known that the difficulty in simultaneously employing wool and cotton, or other vegetable fibers, for textile purposes, arises from the fact that both materials cannot be homogeneously dyed, spun, or milled. The cause of that difficulty is to be looked for in the different natural structure of the two kinds of fiber; the vegetable fiber being straight, while the animal fiber is curly and crisp. The essence of the new invention is this, that, by the agency of certain chemical substances, the vegetable fiber is so efficiently curled, that it permanently retains its altered structure during all manipulations of manufacture, and can be dyed together with wool, and equally fast, by one and the same process. The extreme importance of such an invention is obvious. In the first place, an organic combination of animal and vegetable fibers is at once produced; and secondly, a splendid substitute is found for shoddy and all artificial wools; for this new fiber is not only much cheaper, but excels them all in quality, strength, and durability, and is capable of a far wider application in the manufacture of cloths, blankets, flannels, hosiery, etc., and especially cloth buckskin and all varieties of felt. Hitherto the only representative of the new invention in Europe has been the Cosmos Fiber Company, of Düsseldorf, but its success has been so pronounced, and the interest created so great, that several capitalists are desirous to extend the manufacture into England, France, Belgium, and Algiers. This company will undertake the conversion of the cosmos fiber plants into a material ready for spinning purposes, by subjecting them to a chemical bath, washing, carding, bleaching, or dyeing them, thus producing a substance which, when mixed with wool, may be treated in like manner with it, through every process of manufacture. The results already attained are surprisingly auspicious. Samples of a variety of cloths made wholly or partly from the cosmos fiber have been shown me, which, in respect to color, fineness, homogeneousness, and crispness of fiber, need not fear the severest criticism. Its cost, moreover, is an important item, since it is five times cheaper than wool, and is the only material which can be used in the proportion of 25 to 50 per cent. That is, wool can be mixed with from 25, 33, to even 50 per cent., and yield a fabric resembling all wool, yet good and strong in quality. The above mentioned samples, consisting of two-thirds of fiber and one-third of wool, possess a perfectly blended color, and are of so homogeneous a tissue, that even an expert would, in pulling out the threads, hardly suspect them to contain any vegetable.

The manufacturers and governments of Germany, France, Belgium, and Italy, are taking a lively interest in the invention, which has been patented in those various countries.

At present, the manufacture is confined to the fiber substitute for wool; but a second invention, also patented and the property of the above-named company, is of equally great importance to the textile industries. It touches the utilization in linen and silk manufacture of the so-called ramie or rhea plant (*Urtica utilis*), which grows wild in immense quantities in British and Dutch India, and the French Algerian colonies. The English Government has long been appreciating the vast importance of that plant, and has offered a premium of £5,000 for the solution of the problem of removing the woody and resinous substances of the plant, which premium, however, has never yet been awarded. That problem seems now to be solved, and I have had shown to me partly prepared rhea stalks, the lower end of which was preserved in its natural state, while the upper prepared part showed a silky, long-stapled fiber of extreme strength, which is capable of being further treated in the same way as flax, etc.

The demand upon the Düsseldorf factory for the cosmos fiber has already assumed large proportions, and during the first months of its working—April 1st to Oct. 1st—the not inconsiderable quantity of 75,000 kilos (75 tons) of bleached and unbleached material was manufactured for spinning purposes. And its value and success are so perfectly assured, that one firm alone has arranged for the delivery of 200 lb. per day—a contract which runs for one year.

What a new perspective, then, is here opened out to the wool, silk, and linen manufactures, which are now presented with a raw material of such surprising cheapness and perfection! No one feeling any interest in the progress and welfare of the textile industries can fail to welcome these inventions, which bid fair to give a great stimulus to enterprise and become a new means of enhancing the national wealth.

ESTIMATION OF NITROGEN.

AT a recent meeting of the Chemical Society, London, Mr. Ruffle read a paper "On the Estimation of Nitrogen by Combustion, including the Nitro-compounds." For strictly correct chemical purposes the nitrogen in a substance is estimated by Dumá's method; in analytical practice the process usually employed is the well-known soda lime method of Will and Varrentrapp. It has long been known that with some compounds containing nitrogen this process gives very imperfect results. The author has tried the effect of numerous devices and mixtures, but all yielded results much too low, or were inconvenient. A mixture of sodium hyposulphite and sodium hydrate yielded theoretical results, but had the great objection that it could not be obtained as a powder, only as a wet mass. After many trials the author found that a mixture containing two molecules of sodium hydrate, one molecule of pure lime—from marble—one molecule of sodium hyposulphite—the first two being slaked together, dried, and finely powdered—gave very satisfactory results with all varieties of guano, gunpowder, nitrates of soda, potash, and silver, picric acid, sodium, nitro-prusside, East Indian linseed, milk residues, dried flesh, etc. The author uses ½ in. lap-welded steam piping bored out to $\frac{5}{8}$ in. in 22 in. lengths, for combustion tubing. The substance is mixed with 1½ grm. of a mixture of equal parts of sulphur and wood charcoal, 18 grm. of the above soda lime mixture, and 21 grm. of powdered hyposulphite of soda are weighed off and mixed, 5 grm. of this mixture are placed at the back of the combustion tube, then the mixture containing the substance, then the rest of soda and hyposulphite, finally 18 grm. of ordinary soda lime. The combustion is commenced 4 in. from the front end, and continued gradually until the evolution of gas ceases. It is maintained at a red heat for ten minutes.

DETERMINING PHOSPHORIC ACID.

By DR. B. PEITZSCH, DR. W. ROHN, and DR. P. WAGNER.

THE authors recommend the following process, which has proved satisfactory in the experience of five years.

From 25 to 50 c.c. of the solution of the phosphate, which may contain from 0·1 to 0·15 gramme P_2O_5, are placed in a porcelain capsule with the addition of 100 to 150 c.c. molybdic solution. The mixture is heated on the water bath, with occasional stirring, to about 80°, set aside for an hour, filtered through a plain filter, and the yellow precipitate (which need not be entirely rinsed on to the filter) is washed with dilute molybdic solution. The porcelain capsule is then placed under the funnel, the filter is pierced with a platinum wire, and the precipitate is washed into the capsule with dilute ammonia (2½ per cent.), washing the filter paper well, dissolved, stirring with the glass rod, and the solution washed into a beaker with ammonia of the same strength, enough of which is added to make up a volume of 100 c.c. About 15 c.c. of magnesium chloride mixture are then gradually dropped in, constantly stirring. After the mixture has been set aside for two hours, covered with a glass plate, it is filtered through a plain filter, the weight of the ash being known, and the precipitate is washed with dilute ammonia of the same strength till a portion of the filtrate, after being acidulated with nitric acid, does not show the presence of chlorine with silver nitrate. The dried precipitate is separated from the filter, placed in a porcelain crucible; the paper is charred but not incinerated, and the char placed in the crucible, which is heated first gently, then ignited strongly for ten minutes in a slanting position over a Bunsen burner, and finally exposed for five minutes to a blast flame, let cool in the exsiccator, dried, and weighed.

The first 6 or 8 c.c. of the magnesia mixture should be added very cautiously.

The final ignition before the blast serves to volatilize any traces of molybdic acid which may have been precipitated.

The molybdic solution, dilute molybdic solution, and magnesium mixture should be prepared as recommended in the *Zeitschrift für Analytische Chemie*, 12, 239.

TURQUOISE MINES OF NEW MEXICO.

THESE valuable gems are worked at Mount Chalchuitl (the Indian name for turquoise), about 22 miles southwest of Santa Fé. The rocks in which they are found are distinguished by their white color and decomposed appearance, somewhat resembling china clay, giving evidence, according to Professor Silliman, of great alteration due to the escape through them of heated vapor of water, and perhaps of other vapors and gases, by the action of which the original crystallized structure of the mass has been completely decomposed or metamorphosed. The turquoise is found in little veins and nuggets, covered on the exterior with a white tufaceous crust; but stones of great commercial value are comparatively rare, and many tons of the rock may be crushed without coming to a single specimen. The blue color of the turquoise, which, chemically, is a hydrous aluminum phosphate, is due to copper oxide derived from the associated rocks, of which the Mexico specimens contain 3·81 per cent.

"DRY WASHING" ON THE GILA.

For probably twenty years auriferous deposits in the Gila and Colorado River Valleys, remote from water, have been worked by what is known as the "dry washing" process. In some cases it has been conducted with moderate success. The traveler on the Southern Pacific Railroad of Arizona will notice on the line of the route the excavations made by miners, all of which have been worked for gold by dry washing. This process is naturally very slow, as all the auriferous gravel has to be winnowed after the manner of winnowing wheat, the greater specific gravity of the gold over the alluvium in which it is deposited causing it to act in precisely the same way that grains of wheat do in their relations to the chaff. Some of the methods of dry washing are very primitive. When the wind blows strong the finer material containing the gold is simply sieved in the breeze, when the dust is carried off, while the gold drops perpendicularly to the ground. Of late years various kinds of machines for dry washing have been invented, for each of which especial merits are claimed. The process, at best, is such a slow one that few, if any, persons ever made a fortune by it in "dry diggings." Periodically interest in the dry diggings of Gila and Colorado valleys is revived. Two weeks ago a company of three men took what is known as a dry gold washer from this city to work some ground near Yuma, and it is represented that they have since sent for another. They are credited with reporting that they have taken out $150 per day since their arrival at the field of operation. Another company which took a machine to the same locality, after a five days' run, is credited with having cleaned up $1,500. Still another, after one week's trial, claim to have taken out $1,000 during a week's run. Such reports are not uncommon to all mining localities, and may be taken with as much salt as the reader pleases to season them with. Stories of the fabulous wealth of the dry diggings in the vicinity of Yuma are not new, but they have not thus far added any very great gain to the mineral product of the Pacific coast. The diggings from which these reports now come are represented to be about seven miles from water, which has to be carried that distance for domestic use. A sample of fourteen pounds of the gold-bearing alluvium was sent to this city last week to test, and it is represented to have yielded 80 cents.—*San Francisco Bulletin.*

LUKE BLACKBURN.

OUR engraving is an excellent and faithful likeness of the famous American three-year old race horse, Luke Blackburn, and it is certain to be warmly appreciated all over the country. In the season last past he won twenty-two races, meeting the best horses in the country, and he lost but two, in one of which he fell down. Our first supplement represented the ill-fated Blue Gown. The second was the winning setters and pointers of the field trials. The third was a fine picture of the grand horse Mortemer. The fourth is one of Luke Blackburn, and we have no doubt they will be familiar as household words all over the country, as our subscribers are having them framed. They look exceedingly well.—*New York Sportsman.*

THE AGE OF THE EARTH.

As soon as our earth ceased to be incandescent, and became covered in large part by water, it commenced its depositions of submarine sediments. The oldest known sedimentary rocks, comprising the Laurentian and Huronian systems of Canada, have a total average thickness which cannot certainly be estimated at anything less than 30,000 feet. Sir William Logan indeed, the greatest authority upon these primeval formations, considered the measurable thickness of his Upper and Lower Laurentian alone to amount respectively to 20,000 and 10,000 feet, while he set down the Huronian system as reaching some 18,000 more. But as doubts have been raised whether the Huronian series are not really the metamorphosed representatives of the Upper Laurentian, we will omit them altogether from our calculation, so as to avoid any possible cause of offense. The great Cambrian system, the next in order of time, has a thickness which has been fairly estimated at from 25 000 to 30,000 feet. We will adopt the smaller figure. The Silurian is pretty certainly known to number 6,000 feet. The Old Red Sandstone, with its doubtful contemporary, the Devonian, cannot be put down for less than 10,000. The Carboniferous series amount to at least 12,000 feet, the coal measures alone sometimes attaining to fully that thickness. Thus the whole Primary group, including the so-called azoic rocks, has a total vertical extent of not less than 83,000 feet. By the side of these enormous thicknesses, we can only allow 10,000 feet for the whole of the Secondary formation, from the Permian to the Chalk inclusive, while we shall be generous if we assign 1,000 feet to the little group of the Tertiary and Post-Tertiary deposits. This gives us a total thickness for the whole geological series of 94,000 feet. Let us allow 6,000 more for the breaks between each of these main divisions, or the unrepresented strata, and we have the round number 100,000 feet.

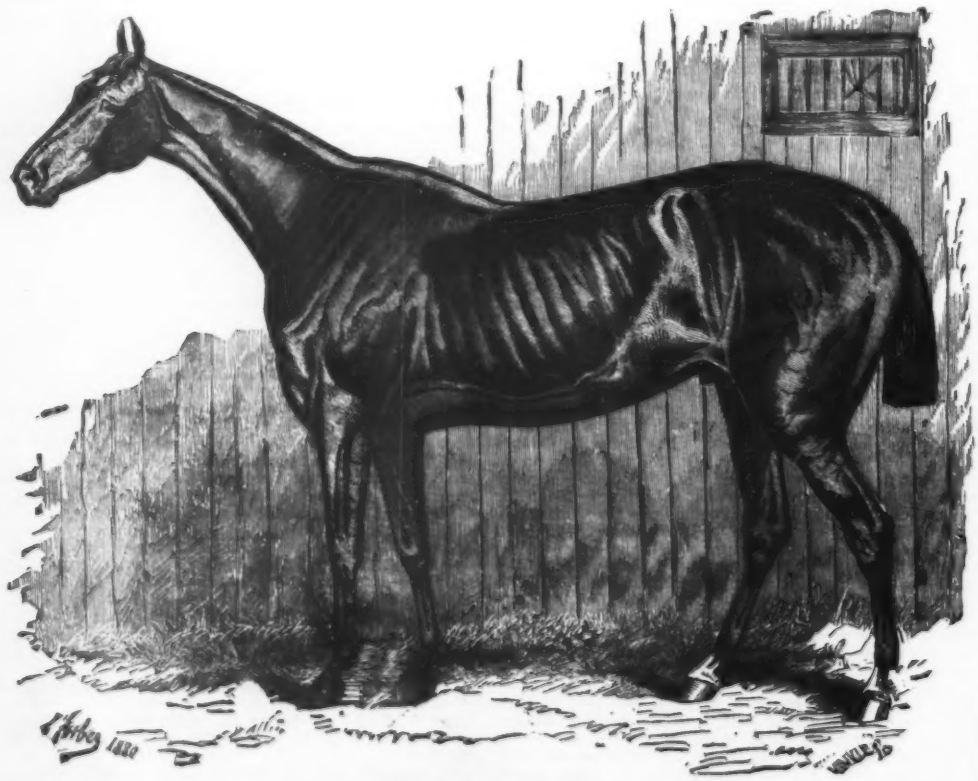
A tabular statement will make these relations clear, and will allow us to translate our known thicknesses into conjectural but relatively ascertained dates:

	Feet.	Years.
Laurentian	30,000	30,000,000
Cambrian	25,000	25,000,000
Silurian	6,000	6,000,000
Old Red Sandstone } Devonian }	10,000	10,000,000
Carboniferous	12,000	12,000,000
Secondary	10,000	10,000,000
Tertiary and Post-Tertiary	1,000	1,000,000
Gaps and unrepresented strata	6,000	6,000,000
	100,000	100,000,000

—*Gentleman's Magazine.*

ALEUTIAN MUMMIES

AT a recent meeting of the California Academy of Sciences an interesting paper was read, entitled "Contributions to the History of the Aleutian Isles," prepared by Dr. Arthur B. Stout, Curator of the Department of Comparative Anatomy, to whom was referred for investigation the two mummies presented to the Academy in 1874 by the Alaska Commercial Co., who received them in response to their instructions to their agents to collect and forward all material for scientific purposes, to be placed in scientific museums here and at the East. These mummies came from the Island of Kagamil, one of the group known as the Four Mountains, or craters. The island contains active volcanoes, and is not now inhabited. In the immediate vicinity of the cave from which these mummies were taken, steam continually rises from a solfatara, and the soil is warm to the touch. Traditions place their age about the year 1756, or when Russians were first seen by the natives. They possess great interest as containing relics indicating the pursuits and handiwork of the Inuits before they were modified by the introduction of any adjuncts of civilization. No implements whatever were found about them. One was that of a woman, the other a man 5 ft. 11 in. high. The wrappings next the bodies were of sealskin. The crania were found entirely empty, and no traces of the viscera remained. The limbs were carefully folded against the body, apparently to make the embalmed package as tight and small as possible. The work is done with evident care and solicitude.



LUKE BLACKBURN.

RECENT PROGRESS IN AGRICULTURAL SCIENCE.

THE objects of agriculture may be briefly summarized as the production of certain plants and animals useful to man. It is the office of agricultural science to investigate and expound the chemical, physical, and biological laws upon which this production depends, while the art of agriculture consists in the application in practice of the principles revealed by the study of the science. Corresponding to the two objects of agriculture just mentioned, we may logically consider agricultural science under the two heads of Vegetable Production and Animal Production, taking up under each one, first, the laws of vegetable or animal production in general, and second, the conditions under which such production is actually carried on.

VEGETABLE PRODUCTION.

Physiology and Bio-chemistry of the Plant.

GERMINATION.—The first act in the life of the plant is the germination of the seed from which it grows. The chemical changes taking place during this process are so similar to those which are continually going on in the mature plant that they may be conveniently considered in that connection, while here we take up briefly some of the recent contributions to our knowledge of the *conditions of germination.* These conditions are, in general, a proper temperature and the presence of sufficient moisture and oxygen.

Effect of Temperature on the Vitality and Germination of Seeds.—Numerous observations on these points have been made within a few years, with the purpose of ascertaining the limits of temperature within which germination is possible, and also within which seeds can retain their vitality.

The observations on the former point have been, in general, confirmatory of those of Sachs, though the minimum temperature at which germination can take place seems to be somewhat lower than is stated by that observer.

Thus Uloth* observed plants of wheat and of a species of maple, the seeds of which had been introduced into an ice-celler along with the ice and had there germinated, and developed plants whose roots had penetrated the ice to a distance of, in some cases, over 16 cm. The germination must have taken place at a temperature little, if any, above 0° C., and as no cracks were observed in the ice, it would seem that the heat developed by the chemical changes going on in the seedling was sufficient to enable the roots to melt their way through the ice.

Kerner† experimented on the seeds of alpine plants, placing them in soil contained in glass tubes which were sunk in the water of certain cold springs whose temperature was practically constant at + 2° C., and found them capable of germination under these circumstances. Kerner also states that many alpine plants not only germinate but grow and blossom under the snow and ice, penetrating the latter in the same manner as the roots of the wheat and maple observed by Uloth.

Haberland,‡ in some earlier experiments, found the minimum temperature for the germination of most seeds to lie between 3·8° and 8·4° C Uloth's observation led to experiments on the effect of a temperature of 0° C. in germination. The experiments were made in a specially constructed ice-chest, on a large variety of seeds, with results differing somewhat from those noticed by Uloth. It was found § that out of twenty-five kinds of seeds, including those of the most important agricultural plants, sixteen, among which may be mentioned wheat, barley, oats, and buckwheat, did not germinate at all; four, viz., rye, hemp, vetches, and peas, did not pass beyond the first stages of germination; while mustard, *Camelina sativa*, Swedish clover (*Trifolium hybridum*), red clover, and lucerne showed a decided growth of the radicle. Nearly all the seeds of rye, about half those of the lucerne, 14 per cent. of the hemp, 17 per cent. of the mustard, and 10 per cent. of the red clover germinated. Haberlandt believes that the seeds capable of germinating at such a low temperature would yield plants needing for their development a less amount of heat than those growing from seeds of the same kind not capable of thus germinating, and that it might be possible in this way to produce early ripening or hardy varieties

The same author has experimented on the germination of the seeds of tropical plants,‖ and has found, as was to be expected, that the minimum temperature for the germination of these seeds is considerably higher than for the seeds of plants inhabiting colder latitudes, ranging from 10° to 15° C. It is worthy of note in this connection that the maximum temperature for these seeds was not essentially higher than for many plants which have become naturalized in temperate latitudes, while the minimum temperature is in many cases considerably higher. Haberlandt considers it as highly probable that, as a rule, those plants which are most widely distributed north and south are able to germinate at the most diverse temperatures.

The maximum temperature at which germination takes place varies considerably with different species, being in some cases as low as 20° C., and seldom rising above 40° C.

The *vitality* of seeds is retained through a range of temperature much exceeding that within which germination is possible. Dry seeds appear to be capable of withstanding quite low temperatures, while if previously soaked in water they are much more sensitive, as has been shown by Haberlandt¶ and by Detmer.** Haberlandt exposed seeds to the temperatures of —10° C. and —24° C.; he found that the former temperature diminished the germinative power less than the latter, that dry seeds suffered less than soaked ones, that quick thawing produced less injury than slow, and that those seeds which contain much oil were best able to withstand cold. The same experimenter†† has observed a curious effect of cold on flax. Soaked seeds of flax were exposed to a temperature of —17·5° C., were then slowly thawed, and sown as usual. The resulting plants showed an abnormal length of stem as compared with plants grown from the unfrozen seed, exceeding them by 39–45 per cent. in this respect. No further experiments confirmatory of this remarkable result have yet been reported.

The highest temperature which seeds can bear without losing their vitality seems to depend largely on their state of dryness, though differences are observed between different species and different individuals of the same species. Thus Just‡‡ found that clover seeds were killed at a tempera-

* "Jahresber. Agr. Chem." 13-15, II., 99.
† "Jahresber. Agr. Chem." 16-17, I., 259.
‡ "Landw. Versuchs-Stationen," 17, 104.
§ "Wissenschaftlich-prakt. Untersuch.," I., 113
‖ "*Ibid.*" I 117.
¶ "Jahresber. Agr. Chem." 16-17. I., 263.
** "Forschungen. Agr. Phys." II., 69.
†† "Landw. Versuchs-Stationen," 21, 357.
‡‡ "Jahresber. Agr. Chem." 16-17, I., 258.

ture of 75° C., in an atmosphere saturated with water, and even at 50° C. did not survive for 48 hours, while dry seeds withstood temperatures below 120° C., though they germinated more slowly afterwards.

So, too, Haberlandt* found that soaking seeds in water of 40° to 50° C. diminished or destroyed the vitality of most seeds, and that even 30° C. was very injurious to some seeds, while V. Hohnelt found that most seeds endured a temperature of 110° C. for an hour, if they were sufficiently dry (3 per cent. or less of water).

The fact of seeds withstanding the action of boiling water for some time, which has frequently been observed, is attributed by Haberlandt to the resistance of the outer coats of the seed to the water, which is thus prevented from reaching the interior of the seeds.

The length of time during which seeds are exposed to a high temperature is also an important factor in determining the result. In general, the higher the temperature and the moister the seed or the surrounding air, the sooner is the vitality destroyed. In some later experiments Just‡ has found that the vitality of some seeds is impaired by the action of moist air at ordinary temperatures, and Haberlandt, in his last cited paper, states that the germinative power of oats and barley is diminished by soaking in water at ordinary temperatures. Other seeds suffer no perceptible injury by such treatment; but as the temperature to which they are exposed is raised they lose their germinative power more and more quickly, until a temperature is reached which destroys it at once, or as soon as the seed has time to become heated through.

It would seem that all seeds lose their vitality after a certain unknown (and probably long) time, and that the action of heat and moisture is simply to accelerate the processes which in any case lead in time to the death of the seed. In accordance with this view, Just (*loc. cit.*) found that exposure of seeds to a heat insufficient to kill them produced much the same effects as long storing, the seed germinating more slowly and feebly, as is the case with old seed.

Presence of Oxygen.—The presence of oxygen, as is well known, is essential to germination, and recent experiments by Haberlandt§ go to show that in some cases the oxygen which is inclosed in the seed itself is necessary to initiate the germination. This observer experimented on seeds out of which the air had been pumped (the seeds being placed under water in the exhausted receiver of an air pump), and found that while in most cases no decided effect was observable, seeds of the oat, beet, and flesole were either incapable of germination or that a far smaller percentage of them germinated than was the case without this treatment.

A certain dilution of the oxygen is also necessary. Böhm‖ has found that seeds are not able to get beyond the first stages of germination in pure oxygen at the pressure of the atmosphere, but that diminishing the pressure to about 150 mm. of mercury, either by dilution with hydrogen or by attenuation by means of the air pump, enables the germination to progress normally.

Too great dilution of the oxygen appears to be equally fatal. Bert¶ found that diminishing the pressure of the air in which the seeds were placed retarded their germination, and that the latter ceased entirely at a pressure of from 4–10 cm. of mercury, though the seeds retained their vitality. He ascribes the result to the decreased supply of oxygen consequent on the diminished pressure. On the other hand, he found that a pressure of 2 or 3 atmospheres slightly accelerated the germination, but that one of 4–5 atmospheres hindered it and a higher pressure stopped it. This result he ascribes to the too great density of the oxygen.

Finally Cossa** has found that nitrous oxide cannot take the place of oxygen. He found that while the seeds of wheat and maize used by him germinated in two days in air or oxygen, no signs of germination were to be seen after twelve days in those placed in nitrous oxide.—*H. P. Armsby, in American Chemical Journal.*

* "Wiss. prakt. Untersuchungen," 2, 47.
† "*Ibid.*" 2, 77.
‡ "Jahresber. Agr. Chem." N. F. I., 234.
§ "Wiss. prakt. Untersuchungen," I., 104.
"Jahresber. Agr. Chem.," 16-17, I., 258.
¶ "Jahresber. Agr. Chem." 16-17, I., 260.
** "Landw. Versuchs-Stationen," 18, 60.

CULTIVATION OF THE FIG IN TURKEY.

THE United States Consul at Smyrna states that the Aidin district is the only one which produces figs for exportation. The fruit will grow anywhere in the neighborhood of Smyrna, of a good quality for consumption, in a green state; but the Aidin plain is unique in its climate and soil as being favorable for the proper curing of the fig. The thermometer seldom falls below three or four degrees under freezing point, and in the summer seldom rises above 130 degrees Fahrenheit in the sun. In Aidin the winters are generally wet, the dry weather commencing in May and continuing till the end of October. Any rain at the end of July, or during the months of August and September, when the fruit is under the process of drying, injures the quality, by causing it to burst, hardens the skin, gives the fig a dark color, and spoils its keeping quality. Heavy dews will cause the same evils.

The fig tree will grow in almost any soil; a rich, heavy soil is, however, preferable; but to produce figs that will dry well and please the merchant, the soil ought to be of a good depth, and of a rich, light, sandy nature; this, if the weather be favorable, will produce large figs, of a white, thin skin, and of the finest quality. Before planting the ground is well plowed two or three times to a good depth, well fertilized, and freed from all weeds and extraneous roots. The fig is propagated from slips, selected with as many fruity buds as possible. To form a tree, two slips are planted, one foot apart, and then joined at the top. The trees, if planted in rich soil, should be placed about 30 feet apart, and for poor soil about 25 feet distant from each other. The cuttings are planted in the month of March, two in each hole, at about 9 inches or a foot apart at the root end, and during the growth of the trees the ground is plowed up two or three times during the winter or spring, and the space between them is used to cultivate cotton, sesame, or Indian corn.

The fig harvest generally lasts about six weeks, and when the fig is ripe it falls of its own accord from the tree. Women and children are employed to pick up the fruit into small baskets, to be conveyed to a place in the garden well exposed to the sun, where they are spread on a bed of dry grass, or matting, singly, and not one on the top of the other, and are turned over every day, in order to get every part of the fig exposed to the sun. After a few days of this exposure, those figs which are sufficiently dry are selected from the mass and divided into first, second, and third qualities, care being taken not to dry them too much. They are then sent to Smyrna, where they are assorted and packed for shipment.

On arrival at Smyrna they are conveyed to the fig bazaar, or market place, where the merchants attend early next morning to effect purchases. The parcels belonging to each individual owner are separately examined, each purchaser giving his own price; a broker is nearly always employed as an intermediary by the merchant, on payment to him of 2 per cent. of the value, the amount being ultimately refunded by the seller. A seller is but seldom the owner himself, this latter being generally represented by a Jew or Armenian merchant, at an exorbitant charge of 7 per cent. as a commission. The figs are then, after purchase, conveyed to the packing establishment, to undergo manipulation and putting into boxes; the sacks are emptied out on the floor in a square heap, and on all sides are squatted rows of women and girls, employed in merely twisting round each fig two or three times between the forefinger and thumb, to render it soft and give it the required oblong form. On the heap are a row of low baskets, into which are thrown separately the first and second qualities, to be used for packing; at least 10 per cent. of the whole mass is worthless for putting up in cases, and, during the first process, the inferior fruit is picked up and thrown in a separate heap. Undersized, tough or spotted figs, and such as are burst, come under this category, and are packed, or rather preserved, promiscuously in small boxes, and labeled "Figs for family use." Sometimes, when the parcel is unusually good, three qualities are selected instead of two. The figs are then laid on long benches, at which are seated the practiced packers. Each man has a box before him, and swiftly and dexterously the figs are placed alongside each other in rows, the rows varying in number according to the depth of the box, the flat ones, which are in more general use, requiring but two. This mode of packing is called "pulled." Above all, a row of "layers" is then placed, to show the figs to advantage. The "layers" are stretched out by means of both hands, and laid flat side by side in parallel rows. Of late years "layers" throughout the boxes have come into great demand, and nearly all the best qualities are packed in this way. In packing the fingers are now and then dipped into a bucket of sea-water to ease their working; the figs become thus moistened with salt water, which, it is said, has the effect of hastening their sugaring. The boxes are again passed on to the women, who complete the process by placing laurel leaves between the upper rows, before the final nailing down and polishing off by the carpenter. The packages used are of various dimensions and forms; at one time all figs exported to the United States were placed in drums or paper boxes, but of late years flat wooden boxes are being extensively shipped. Very few drums, if any, find their way to the English market, to which the best qualities are usually sent. America consumes but little of the superior qualities, though the demand for such has now increased. Small canvas bags are now being used with much success, and, in fact, every season some novelty in the style of packing may be noticed. The refuse, or "naturals," are put into large boxes or barrels, and shipped to England, Egypt, Europe, and Turkey, the high rate of duty in America entirely excluding those inferior figs from the market.

THE TRAFFIC IN DRIED FRUITS.

THE perishable nature of all kinds of fruit has led to the employment of many methods for its preservation, the most primitive of which is probably that of drying. Although recent improvements in canning processes have created an increased demand for canned fruits, the market for the dried article is brisk every year. Many commercial firms in this city deal almost exclusively in dried fruits, or make this article a leading specialty. Besides the demand for dried fruits in this market there is every year a large demand for export to foreign countries. Dealers also do a large trade with the Western States and Territories. In many of these, especially the later settled districts, farmers have not had time to grow orchards as yet, and so must buy their fruit, both fresh and preserved. Dried fruit is also much used in the mining regions, being easily transported; and the miner must often take his choice between dried-apple pie or none at all.

Dried peaches, berries, plums, and cherries find a good market in the Western States, and are made into pies, puddings, and sauce. Few of these smaller fruits are exported, the foreign demand being chiefly for apples. Of these there were exported in October of the present year 1,853,044 pounds, and in the first ten months of the year 4,499,156 pounds. The export trade has increased largely of late, as will be seen by the record of 1874, when only 1,202,792 pounds were exported. In 1876 the exports rose to 6,900,536 pounds, and last year, when the apple crop was much less than the present year, there were exported 5,895,256 pounds. France, Germany, Belgium, and England are all using more dried apples this year than usual. This is the result of the general failure of the apple crop in those countries, and also of the unusually low prices in this country. "Evaporated" fruit, which sold last year at from 13 to 16 cents a pound, now sells at from 6 to 8 cents. Common fruit, which last year brought from 7 to 9 cents, now brings only from 4½ to 5½ cents.

On account of the general failure of the grape crop as well as the apple crop in France, the distillers in that country are using large quantities of dried apples for the manufacture of brandy. The common grades of apples are preferred for this purpose, especially southern fruit, which is said to yield 10 per cent. more alcohol than ordinary fruit. An import duty of half a cent a pound will be levied on dried apples in France after January 1. Previously dried apples have been on the free list in that country. The exporting of the ordinary stock tends to keep the market firm, and dealers are generally confident of good prices. The English market will take little except evaporated apples, and it is only within a few years that any have been shipped there; but the demand now is steadily increasing. For the German market fruit dried in quarters is preferred. "Sun-dried" apples are about the only kind shipped to Continental Europe.

The "evaporated" apples are dried very quickly by artificial heat in a carefully constructed apparatus. After being peeled, cored, and sliced transversely into thin rings the fruit is subjected to the fumes of sulphur, which causes the white color of the apple to be retained in drying. So effectually does this fumigat on arrest decay that quantities of the apples may be left several days before drying without injury. "Evaporated" apples are generally packed in wooden boxes containing about fifty pounds. The common grades are packed in barrels.

All of the older States send more or less dried apples to this market. New York State takes the lead, and Ohio and Indiana come next. Tennessee and other States in the southwest also send large quantities. Dried peaches and blackberries come in large part from North Carolina. Peaches are also dried by the evaporating process, and there is some demand for these in the English market. Although there is a very large yield of apples this year, dealers say that there will not be a correspondingly large amount dried. The reasons given are that driers generally anticipated that large quantities would be dried and that prices in consequence would be low; accordingly they were afraid to engage in the business very largely. It is also stated that the cold weather coming so early in the season destroyed many apples that otherwise would have been dried.—*N. Y. Tribune.*

THE SURGICAL USES OF WIRE-CLOTH.

By J. S. WIGHT, M.D.

WIRE-CLOTH is made of wire, as any other cloth is made of thread. Wire-cloth suitable for surgical uses is made of wire from one-twentieth to one-tenth of an inch in diameter; the meshes are from three-tenths to five-tenths of an inch square, or the length of the mesh may be greater than the width. After the cloth is cleaned with acid, it is put into melted zinc, which covers the wires and fastens them quite firmly together where they cross each other, making a firm and strong structure.

About the year 1870 I began to put wire-cloth to surgical uses. Since that time I have used wire-cloth quite constantly, and have noted that other surgeons have used it. And the more I use it, the more valuable it seems to be to meet certain indications to be mentioned as we go on. In passing, I may mention that the use of wire-cloth in surgery is not new; but the kind of wire-cloth I have described is somewhat new as employed in surgery, and, as far as I know, was first introduced to the profession by myself.

In the first place wire cloth can be cut into any desired shape by a pair of shears for cutting tin. The separate wires may be cut out by a pair of so-called French pliers. The pieces of wire-cloth may be bent into any required form by the hands of the surgeon; and, when bent, it will generally have enough firmness and resistance to keep its form under all ordinary circumstances.

Wire-cloth is very light—having the same extent of surface, it is lighter than wood, tin, zinc, or binder's board, used for splints. I have verified this statement by experiment.

Wire-cloth is porous, or, rather, it is full of holes, and ventilates the part to which it is applied better than any other splint material. It is very desirable where irrigation is needed; and it does not absorb moisture. At any time it can be removed, disinfected, and reapplied with facility. These are very superior advantages.

Wire-cloth generally has sufficient firmness to keep reduced bony fragments in place; but if need be, it may be fastened to light strips of wood by small staples, in order to make it firmer.

Strips of wire-cloth may be used to strengthen plaster-of-Paris, when used for the spinal jacket, or for fractures, simple or compound. An admirable use of wire-cloth is in fenestrating a plaster-of-Paris splint in a case of compound fracture; for it enables the surgeon to make a light and firm splint, having the firmness about the fenestrum, where it is much needed. And a piece of wire-cloth makes an excellent trap door to cover the fenestrum, into which a piece of oakum can be put, making gentle pressure on the soft parts. I can recommend a splint in which plaster-of-Paris and wire-cloth are combined.

Wire-cloth may be hinged on a board splint, as you see in this specimen, for treating a severe wound of the fore-arm—especially when there has been a compound fracture of one or both bones. This is an excellent appliance for keeping bony fragments in place, and for holding oakum, which acts both as a pad for the splint and as an absorbing material for the waste products of the wound. The wire-trough can swing as a door on its hinges, permitting the wound to be dressed, while leaving the fore-arm on the board splint, and can then readily swing back into place. In the meantime the bony fragments need not be disturbed. I can testify to the great advantage of this appliance by its use in the treatment of several cases of severe injury to the fore-arm.

Wire-cloth may be made into buckles of various sizes by cutting out part of the wires of some of the meshes, and leaving the rest of the wires for tongues, which, cut obliquely, can penetrate a bandage and fasten it evenly and firmly around retentive splints. Here is a buckle, and I show you the method of using it. The bandage can be made loose or tight, as the case requires. These buckles are inexpensive, and prevent the objectionable results coming from knots tied in bandages.

A retentive buckle, to be applied to the top of the head, in case of fracture of the lower jaw, may be made of wire-cloth. The retentive buckle extends from the upper border of the forehead to the occipital protuberance, and has three sets of tongues on each side—one in the middle and one at each end. The middle of a six-tailed bandage is applied to a sub-mental splint: (1.) The posterior tails of the bandage are brought forward to and held by the anterior tongues of the retentive buckle. (2.) The middle tails of the bandage are carried upward to and held by the middle tongues of the retentive buckle. (3.) The anterior tails of the bandage are carried backward to and held by the posterior tongues of the retentive buckle. In several cases of fracture of the lower jaw treated by me, the retentive buckle has met the indications in an admirable manner.

The sub-mental splint may be made of wire-cloth by simply cutting a small quadrangular piece, as one makes a four-tailed bandage, and then bending it into proper shape with the hands. This sub-mental splint is especially adapted to the treatment of a compound fracture of the lower jaw, because it can be kept in an antiseptic condition.

Cut a piece of wire-cloth so that it will have a length about three inches greater than the arm, and a width somewhat greater than the semi-circumference of the arm. Cut out the two middle meshes of one end for about three inches, and then bring the two tongues together, overlapping them and tying them with a strong twine, so that they will meet the rest of the piece at an angle equal to the angle at the shoulder to which it is to be applied. The result will be an arm-splint having a shoulder cap that can be fastened on the shoulder by a bandage passing under the axilla and over the shoulder cap, which is padded and rests on the shoulder. This splint can be used for treating fractures of the humerus. However, a piece of board fastened to its distal end for supporting and keeping the fore arm quiet, and preventing motion of the bony fragments, is a useful addition. By means of the piece on the fore-arm and the shoulder-cap, it is possible to make considerable extension on the lower fragment of the broken humerus.

I know of nothing better or more convenient than wire-cloth for making double-angled splints for treating fractures of the condyloid end of the humerus in children. The double-angled splint has two angles: one angle is generally a right angle, made by the meeting of the long axes of the arm piece and the fore-arm piece of the splint. The other angle is generally one of 135 degrees, made by the meeting of the long axis of the arm and the transverse axis of the plane of the fore-arm.

The anatomical basis for this splint needs some attention: Put the arm by the side, in an easy position, and flex the fore-arm till it meets the arm at a right angle. The right angle of the splint conforms to the right angle at the elbow. Put the bones of the fore-arm in the same plane, which will be nearly perpendicular. The transverse axis of the fore-arm will meet the long axis of the arm at an angle of about 135 degrees. The oblique angle of the splint will correspond to the oblique angle of the arm and the plane of the fore-arm.

Here is a small double-angled splint, made of wire-cloth. At first it is cut, so that the arm piece and the fore-arm piece meet at a right angle; and then it is bent at the elbow, so that there is an oblique angle made by the plane of the fore-arm piece and the arm piece. Here is a large double-angled splint, made of wire-cloth and a piece of pine board. The piece of pine board is applied to the dorsum of the fore-arm, and the piece of wire-cloth is applied to the outside of the arm. This splint is made for an adult. The small splint is strong enough for a child, when made only of wire-cloth.

Some of the advantages of the double-angled splint may be mentioned in this connection. In a case of fracture of one or both bones of the fore-arm, this splint will keep the fragments in the same plane, the fore-arm being in a state of mid-rotation, so that if there be anchylosis of the radio-ulnar joint, the fore-arm will be in the most useful position. It will be seen, also, that the fragments of bone in general will be kept further apart, so that the radius and ulna will not be so apt to unite with a bony bridge. And for reasons that may not be detailed now, the muscles are put more completely at rest—especially the supinator longus—which can be shown to be a powerful flexor of the fore-arm, and as much a pronator as supinator.

In a case of fracture of one or both condyles of the humerus, or in case of a supracondyloid fracture of the humerus, the double-angled splint will meet two important indications: (1.) By putting a shoulder-cap on the arm piece of the splint it is possible to make extension on the fore-arm and counter-extension on the axilla. (2.) By putting the fore-arm in a normal relation to the arm, the distal fragment will not be so apt to tilt from its normal relation to the proximal fragment. The effect will be a tendency to prevent undue angular displacement of the distal fragment.

Also, in a case of dislocation of the fore-arm, or of sprain of the elbow joint, the double-angled splint, after reduction of the dislocation, is well adapted to keep the bones in their normal relation, as well as put the muscles that span the injured joint in a state of repose. The relief expressed by a patient on the application of this splint, and the rapid recovery that follows, outside of anatomical and theoretical grounds, has favorably impressed those who have seen it used. A proper degree of pressure can be made by the wire-cloth, and any lotion that is desirable can be applied to the injured part, while the splint can be removed at any time to permit passive motion.

I have used the wire-cloth in making an anterior suspension splint for the lower limb, when there has been a compound fracture of the shaft of the femur; and, so far as I can judge at present, it is entirely competent for such work, and the angles for the groin, the knee, and the ankle can be easily made by bending the cloth with the hands.

In a case of injury to the foot or ankle, or in a case of resection of the ankle joint, a piece of wire-cloth, having a leg piece and a foot piece meeting at a proper angle, has done good service, not only when moist dressings, but also when dry dressings were applied. The form of this foot-and-leg splint is best when based on anatomical relations, and need not detain us now.

It has not been my intention to enumerate all the surgical uses of wire cloth. My intention has been to draw attention to the usefulness of wire-cloth in surgery. I have not intended to make wire-cloth a hobby. I have endeavored to let this material vindicate its own place in the field of surgery, and it seems to me that it has done this. What I desire is to make the usefulness of wire-cloth more widely known. Wire-cloth is a good thing—both for the surgeon and for the patient.

For the purpose of illustration, permit me to exhibit to you a man who has on his person the following surgical appliances made of wire-cloth: (1.) A retentive buckle on the top of the head. See how well it keeps its place; there is nothing better. (2.) A sub-mental splint, as good as one of any other material, and more readily made. (3.) A shoulder-cap of simple construction and practical utility. (4.) A double-angled splint, which fits the anatomical relations, and keeps from slipping off the cone of the fore-arm.—*Proc. Med. Soc. Kings Co.*

PASTEUR'S DISCOVERY OF THE "VACCINE" OF FOWL CHOLERA.

M. PASTEUR has at last made known the method by which he claims that the virus of fowl cholera can be modified so as to produce a morbid disease which has the same protective power against the original disease that vaccinia has against smallpox. M. Pasteur's communication on the subject is of extreme interest, on account of the bearing which the alleged discovery has to all infectious diseases. Fowl cholera itself is not a disease of much consequence; it is not a cholera at all, but is a highly virulent blood infection, characterized chiefly by fever, swelling of the cervical lymphatics, pericarditis, and duodenal congestion or inflammation. Its termination is frequently fatal, but not necessarily so, and the poison seems to differ in the degree of its virulence at different times. The special poison of the disease, according to Toussaint and Pasteur, is an oval-shaped micro-organism about one-forty-thousandth of an inch in diameter. This organism can be easily cultivated in certain media, such as decoction of muscle; and it was by cultivating it in these media that Pasteur obtained the results he now announces.

In describing his investigations, the facts of the variable intensity in the symptoms and course of the different infectious diseases is referred to. It being admitted that such a variability does exist, the problem proposed by an experimenter was to take the infective organism in cases of virulent fowl cholera, and try whether, by artificial cultivations, the intensity of their effect could not be diminished. It was found that if these micro-organisms were subjected to [illegible] rous cultivations immediately succeeding each other, the virulence was not at all diminished; but if the intervals between the cultivations were prolonged, a gradual diminution in intensity did take place. Thus, for example, the germs from a very malignant case may be placed in a muscle-decoction, and there allowed to multiply. Multiplication having ceased, the decoction is allowed to stand for two months; some of it is then taken and placed in fresh culture-fluid, where growth and multiplication again occurs. Now while the inoculation of the first decoction will kill ten chickens out of ten, and that in a sudden manner, the virus of the second decoction does not kill at all, or at least it will have lost its *foudroyant* character. If the time between the successive cultivations is extended to six, eight, or ten months, the virulence of the poison continues to become weaker, until it finally causes simply a mild disease that does not injure the fowl, but protects it from the effects of any further inoculations even with the freshest and most virulent organisms.

This is M. Pasteur's method of obtaining the protective virus of fowl cholera.

The next question which he proposes is: What is the agent that causes this progressive diminution in the intensity of the special poison? He found that cultures which were kept preserved from the atmosphere in hermetically closed tubes did not lose their virulence in the least, although preserved for ten months in this manner. Cultures from the same source, that were exposed to the air, gradually lost their strength, as has been described. M. Pasteur finds in this fact a clear demonstration that it is the oxygen of the air which weakens or extinguishes the virulence of the poison; and he believes further that this is not merely an isolated fact, but possibly the grand principle that to this influence is due the modification and limitation of great epidemics.

This, as well as the other of M. Pasteur's communications on the subject of fowl cholera, read very much like a romance. It must be said, however, that he is not alone in announcing discoveries of the kind just described. M. Toussaint states that he has been able to modify the poison of anthrax, so that after its inoculation in healthy animals a morbid action is produced which removes the susceptibility to the original poison. Only in M. Toussaint's case the alleged infective germs were removed from their fluid medium instead of being cultivated in it. He took the blood of animals affected with anthrax and destroyed the organisms in it by filtration and carbolic acid. He then injected the filtered fluid into healthy animals, and found them protected by it against the anthrax.

Similar experiments with the virus of splenic fever have been made by Dr. Burdon-Sanderson and Dr. Greenfield. The latter showed that if a guinea pig be inoculated with the blood of a heifer suffering from splenic fever, the former animal takes the disease. Then, if the blood of the guinea pig be inoculated in a healthy heifer, it will protect that animal against splenic fever. Still other experiments by Buchner and by Koch, showing the apparent possibility of changing by cultivation the supposed specific properties of micro-organisms, have been made.

All these investigations have led their authors to conclusions which, if correct, are of a vast importance to pathology as well as to practical medicine.

While hoping that these experimenters are not deceived, we cannot but remember that the history of specific germs is full of the wrecks of brilliant hypotheses. From Hallia, with his rice-fungus, to Oertel, with the diphtheria spores, the story has been one of laborious experiment, alluring theory, then refutation, and final collapse. There is a remarkable medico-geographical fact also in this connection. It is that all the specific micro-organisms, except a few in Ohio, live on the other side of the Atlantic and cluster around the laboratories of a few pathologists. Therefore it is not surprising that some incredulity be shown toward specific germs, in whose geographical distribution there is shown such a conspicuous bias.—*Medical Record.*

SOMETHING ABOUT MOSSES.

AT the stated meeting of the Biological and Microscopical Section of the Academy of Sciences, Philadelphia, held Jan. 17, 1881, Director Dr. R. S. Kenderdine in the chair, in the absence of the lecturer for the evening, the director called on Dr. Hunt for some remarks. Dr. Hunt said that he knew but very little about cryptogamic botany, but had observed that the finer longitudinal lines on the divisions of the peristomes of some mosses, when properly displayed under a good lens, were easily resolved into distinct "dots," much like the dots on the pleurosigma and other diatoms. But if carelessly illuminated, or inferior lenses of small angle were used, the true structure did not come out. It seems to be nature's way of working in the almost endless markings and engravings to be found ornamenting plant-surfaces, and which look like lines on careless observation, are only dot-like elevations when critically viewed. Although these dots are often less than one-twenty thousandth of an inch apart, yet there are quite clear spaces between them.

Another beautiful object among the cryptogams, and now displayed under a microscope on the table, is the annulus of a moss. It is formed of one or more rows of imbricated andelastic cells, which lie upon and around the orifice of the sporangium in some mosses. Seen *in situ* it is almost as beautiful as a delicate lace collar encircling the neck of an elaborately dressed lady. But this gauzy collar of the moss has other significance than ornamentation. In order to have this significance intelligently before us, we will glance rapidly at a moss—the Funaria—from its birth. The spore—so-called—germinates in the damp earth, in the shade, as all earth-loving creatures do; somewhere along the fruitful margin of that universal water brook that meanders through every land. A minute, green, septate, algoid filament creeps out of the moss spore. This lengthens and ramifies into many branches. It is called the protonema. It is the cryptogamic cradle in which the shy moss-mother first rocks her potential children. From this protonema numerous buds or tubers grow out, and, in time, form patches of moss-roots, which throw up aerial branches covered with soft, green leaves, clothing life's wayside with sweet places on which the child and the old man alike may rest and eat of the lotus. Many mosses remain in this condition for seasons; but others arrange household affairs differently.

Among their soft leaves, in special places, essential organs appear; these learned botanists call antheridia and pistillidia. In the antheridia, peculiar cells are developed, each one of which is a spiral cilium, intensely alive—brimming full of ancient sunshine, and when mature and free, eel-like, swims about in a drop of water, as a serpent might in the sea.

How strange it is that nature concentrates in a spiral cilium the life of every vascular cryptogam; yes, and of each higher animal, too, at some momentous era of its existence. Among the plants it is called antherozoid, among animals spermatozoid—both names of equal significance. The moss cilium touches the germiferous tissue in the pistillidium, and a little filament rises from the spot, bearing at its top a sporangium filled with spores all sealed in tightly by the folded peristome and closely fitting operculum at the top. But just beneath this operculum lies the elastic annulus, which I said was beneath the microscope on the table. Now, just when these spores are ripe, and not before, this annulus, like a spring, throws off the operculum, liberates the golden spores, and empties these forest urns of millions of living germs.

Nature fills her urns with emblems of coming life; man puts into his only the pale ashes of the dead.

All sporangia among the cryptogams, by whatever name they are called, have double walls, and if these walls are thick, stomata are found on them, but if they are thin, no use for stomata would exist, and they are never present. A beautiful illustration of this compensation in nature is found in the fronds of Hymenophyllum. Only one layer of cells make up the fronds of these ferns, and stomata are absent. They would be superfluous. In the prothallia of ferns there are no stomata. Here, too, we have only one layer of cells, and no stomata, because the air comes in close relationship with all the cells, and stomata would be superfluous.

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